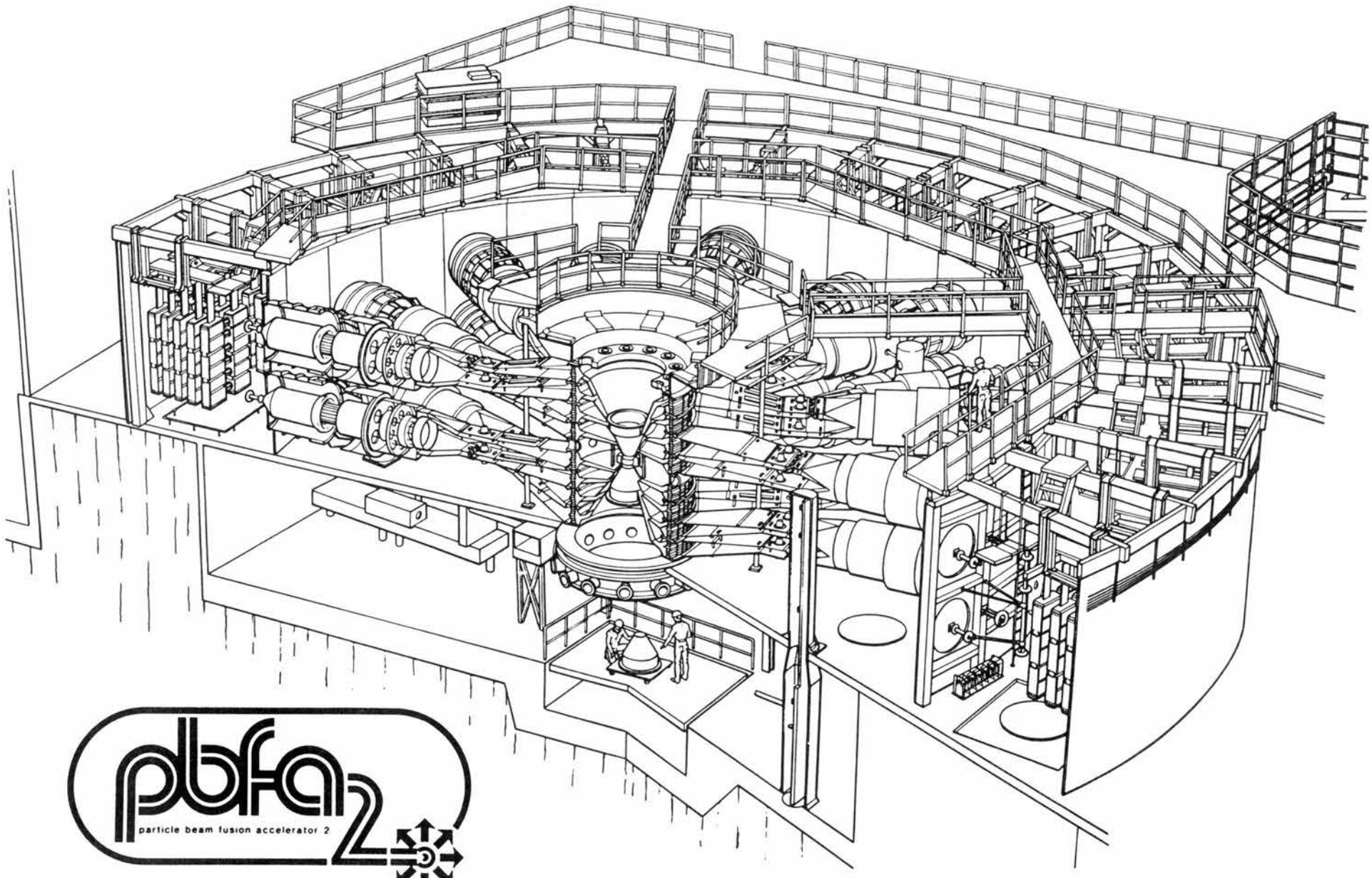


PBFA II is now believed to be the only fusion experiment in the world with the possibility of igniting thermonuclear fuel in the laboratory. Each of the 36 spokes in the 108-foot diameter wheel is a pulsed power generator identical to the Demon module that recently passed several tests in preparation for installation in the accelerator.

Major Step Toward Fusion Ignition

Focusing 'Scale Up' Works

LAB NEWS
VOL. 37 NO. 7 SANDIA NATIONAL LABORATORIES APRIL 12, 1985

The likelihood of Sandia's achieving early success in harnessing the world's most powerful particle accelerator to ignite fuel pellets for fusion power research has increased greatly as the result of new experiments by Pulsed Power Sciences 1200.

These results show that a successful technique developed to focus energy from smaller accelerators can be "scaled up" to much larger machines.

Target experiments leading to ignition of a fuel pellet will be carried out in Area IV on a powerful new accelerator, PBFA II (Particle Beam Fusion Accelerator II), beginning in 1988. Designed to deliver at least 100 trillion watts of power, PBFA is in its final year of construction. Its first test shot is scheduled for January 1986.

The recent scaling experiments were of critical importance to successful operation of PBFA II. "Focusing is potentially the weak spot in ion beam fusion," says Don Cook, manager of Fusion Research Department 1260. "Particle beam accelerators are extraordinarily powerful and efficient, but you must be able to focus their output on the fuel pellet.

"The new scaling experiments indicate that PBFA II will be able to focus an intense ion beam. I think the most difficult question in scaling from small machines to large machines has now been answered."

"As a result of this accomplishment," said Bill Brinkman, vice president of Research 1000, "we have a very reasonable chance of becoming the first lab in the country to achieve fusion ignition. That means we may well become the first to achieve break-even — where the machine starts to produce more energy than it consumes."

Sandia is the lead laboratory for fusion with light ions in the nation's inertial confinement fusion (ICP) program, funded by the DOE.

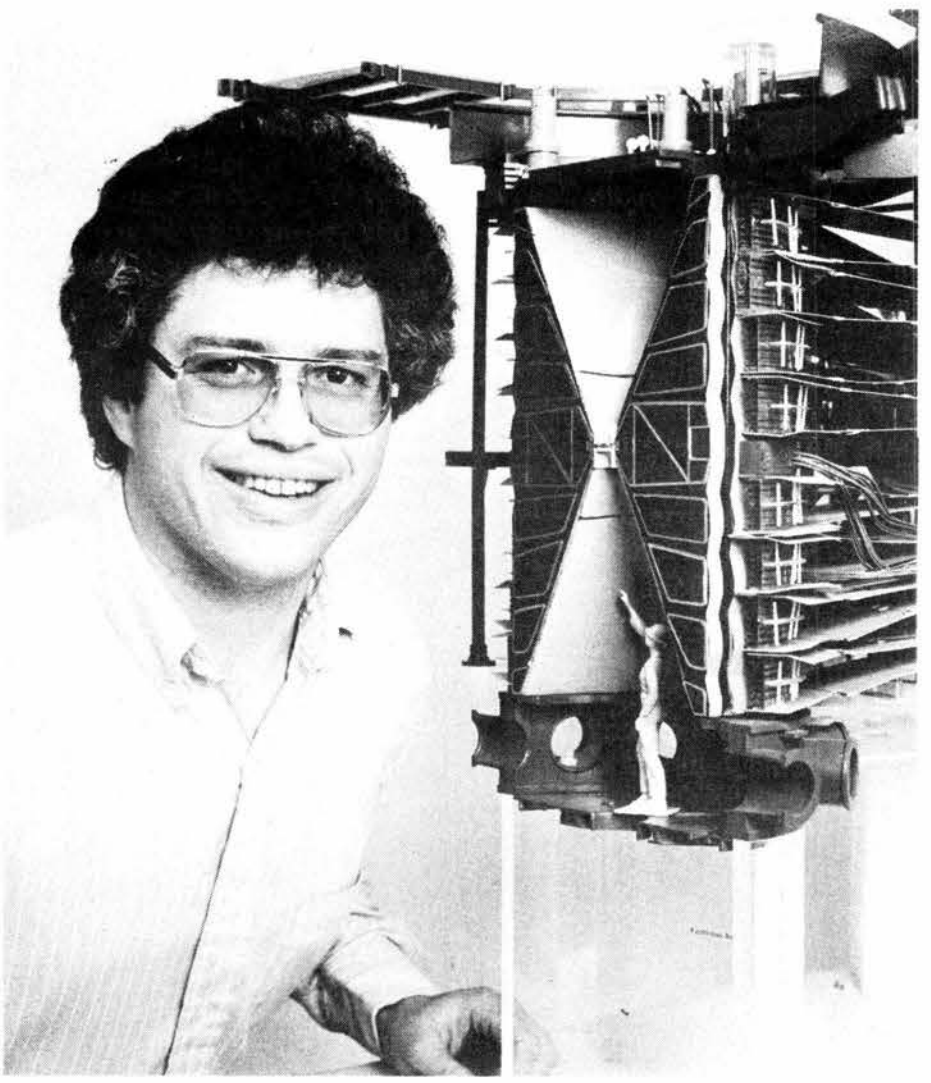
The success of ICF experiments hinges on the effectiveness with which intense beams of energy — ion beams (charged particles) or laser beams (light) — can be directed onto a small fuel pellet and cause its atoms to "fuse" or combine and thereby release energy. The experiments are directed toward understanding the physics of small implosions. Eventually, it is hoped, this process could be used to produce electrical power from deuterium and tritium, which are forms of hydrogen, the most abundant element in the universe.

Earlier focusing experiments (LAB NEWS, June 8, 1984) represented the first time an intense beam of ions had been directed to a spot the size of a pinhead, representing an intensity at the focus of 1.5 trillion watts per square centimeter. This is akin to focusing — for an instant — all the electrical power generating capacity of the United States onto an area less than the size of a fingernail. The achievement was a proof-of-principle for focusing intense ion beams and demonstrated that instabilities in the particle flow would not disrupt the ion beam.

The next challenge was to scale those results to a larger accelerator. That has now been accomplished. Researchers in

(Continued on Page Two)

Focusing 'Scale Up' Works



'SCALE UP' WORKS. That's the conclusion recently announced by Fusion Research Department 1260. John Maenchen was project leader for the tests that proved that earlier focusing achievements could be scaled up to larger accelerators. John made some important contributions to beam focusing to produce the result. Here, he poses with model of PBFA II with the Applied-B diode in the center (at the apex of the two cone-shaped structures).

Continued from Page One...

Pulsed Power Science 1200 using the PBFA I accelerator, with 8 trillion watts delivered to the accelerating structure, matched the focal intensities achieved last year on a smaller (600-billion-watt) accelerator, Proto I.

PBFA II will produce a 30 million-watt, 5-million-amp beam of lithium ions. This boost in voltage and ion mass — while current stays essentially the same as on PBFA I — should make the PBFA II beam substantially easier to focus. The 1.5 trillion watts per square centimetre on PBFA I indicates that PBFA II should produce more than 100 trillion watts per square centimetre for target experiments. With 1 to 2 million joules of energy on target (1 million joules is the energy of a large car going 60 miles per hour), PBFA II will have the possibility of igniting thermonuclear fuel in the laboratory for the first time.

The beam in the new experiments began as electrical energy at the perimeter of the 96-foot-diameter PBFA I. The energy was compressed in time and space from the perimeter to the 30-centimetre-diameter cylindrical diode — the device at the center of the accelerator that converts the powerful electrical pulses into focused beams of ions (see related story). The diode converted the energy to protons (hydrogen ions) and focused them — in a shot lasting 40 billionths of a second — onto a spot 4 to 4.5 millimetres in diameter — about half the size of a shirt button.

Another piece of good news: The high-intensity focused beam was achieved without many of the hardware improvements that Sandia scientists have planned.

"These high intensities were achieved by solving the ion-beam-aiming and beam-transport problems," says project leader and chief experimentalist John Maenchen (1263). "We are now addressing our other avenues of improvement: power coupling, the ion initiation mechanism, optimizing the source shape, and improving beam transport."

Given the recent successes, Sandia scientists now express confidence that the experiments can achieve focal powers beyond the level required to scale to PBFA II. That should enable this frontier-technology accelerator to power experiments on many types of fusion targets.

"The likelihood that PBFA II will be able to focus an intense ion beam has gone way up," says Don. "The first step — feasibility — and the second step — current scaling — have been successful. The third step — voltage scaling — can be taken only on PBFA II."

Ion beams are attractive for igniting fusion fuel pellets because they can deliver energy efficiently, if they can be made to focus. In contrast, laser beams, which can be focused very easily, are much less efficient than ion beams (see related story).

"The ultimate beam for inertial confinement fusion will be both efficient and focusable," says Don. "With these results, we have now made a significant step in that direction."

The high ion intensities were achieved with the help of a cylindrical plastic mesh inserted between rings of the diode's nega-

Fuel Pellets: Spherical Rockets

Conditions for Fusion Are Rigorous

The fuel pellets used in inertial confinement fusion are tiny — like BBs or small marbles. But they are potentially the most powerful tiny devices mankind has ever known.

When, one of these years, the full force of a powerful accelerator like PBFA II is brought to bear on a pellet, it will release some 100 times as much energy as it took to ignite it. That release of energy has enormous implications for power generation and other fields.

It's simple in concept — just uniformly compress the fuel to 1/1000th of its liquid density, then heat it to 100 million degrees C so it becomes a plasma. Under those conditions, the pellet's components, atoms of deuterium and tritium, overcome their mutual electrical repulsion and fuse into helium atoms, giving off energy ($E=MC^2$). It's the same process that fuels the sun and the other stars.

A power-producing fusion reactor would ignite perhaps 10 fuel pellets per second. They would be inserted one after another in somewhat the same way that gasoline vapor is repetitively squirted into an engine's combustion chamber. The energy produced, in the form of heat, would be used to drive conventional power generators.

But it's not easy to produce and harness the 100 TW (100 trillion watts) of energy it takes to initiate this thermonuclear reaction — the years of intense research at Sandia and many other laboratories around the world have proved that.

"The ignition of a thermonuclear fuel in the laboratory would be a major scientific achievement," says Pace VanDevender (1200). "It would permit inertial fusion to be developed as a laboratory source of radiation for nuclear weapons effects, nuclear weapons physics research, research on strategic defense, and the eventual application of inertial fusion to energy production."

Fuel pellet fabrication is a mixture of art and science. Very challenging fabrication requirements stretch the state of the art in many areas. Los Alamos National Lab has developed extensive pellet fabrication facilities to develop targets for the Los Alamos and the Sandia programs. Pellets for PBFA II will be fabricated at Los Alamos and fielded collaboratively.

A pellet has a shell enclosing the deuterium and tritium; both are heavy forms of hydrogen, and widely available in sea water and nuclear waste, respectively. One thimbleful of such fuel can produce as much energy (in the form of energetic neutrons) as 20 tons of coal.

The outer portion of the shell, when zapped by enough energy under the right conditions, acts like a rocket exhaust: as it explodes outward, the inner portion of the shell pushes inward — implodes — brutally squeezing and heating the plasma to the fusion point.

Just another application of Newton's third law of motion ("For every action, there's an equal and opposite reaction"), that's all.

Good News for PBFA II

Demon Passes All Tests

One of 36 identical modules in PBFA II successfully completed all its tests recently. The 36 modules have been ordered, and installation has begun. All work is on schedule.

The modules — each a generator of pulsed power — will be arranged radially, like the spokes of a huge wheel, inside PBFA II (Particle Beam Fusion Accelerator II). Completion of construction and the first test shot on the $48 million machine are scheduled for January 1986. The first fusion pellet experiments are set for 1988.

Since PBFA II is a modular accelerator, it made sense to build and thoroughly test one module before procuring the other 35 units. The module is called Demon (for "demonstration" accelerator). More than 50 feet long, it contains all the components that make up one module in PBFA II. This provided a full-scale experiment on which the Sandia scientists and engineers could verify their computer projections on a single module.

These tests, which began last year, show that the module operates as expected, providing the necessary voltage, energy, power, and pulse length. This finding provides confidence that PBFA II will achieve all its design goals and deliver 1 to 2 million joules of ion beam energy onto a fusion pellet target with a final power of at least 100 trillion watts.

These are the energy and power levels considered necessary to ignite a fusion fuel pellet.

The components for the Demon module were developed — when viewed as one of 36 spokes in a 108-foot-diameter wheel — from the "outside in." This is the same sequence that electrical energy follows in being compressed and channeled in time and space to generate the intense power needed in PBFA (see related story).

The process begins with a Marx generator, a large bank of 60 high-voltage (100,000-volt) capacitors where electrical energy is slowly stored and then quickly released. The 5-million-volt pulse of energy then goes into intermediate storage capacitors and becomes further compressed in time to gain greater power. From there the pulse crosses a newly designed laser-triggered gas switch in intense sparks. This switch synchronizes all 36 modules of PBFA II.

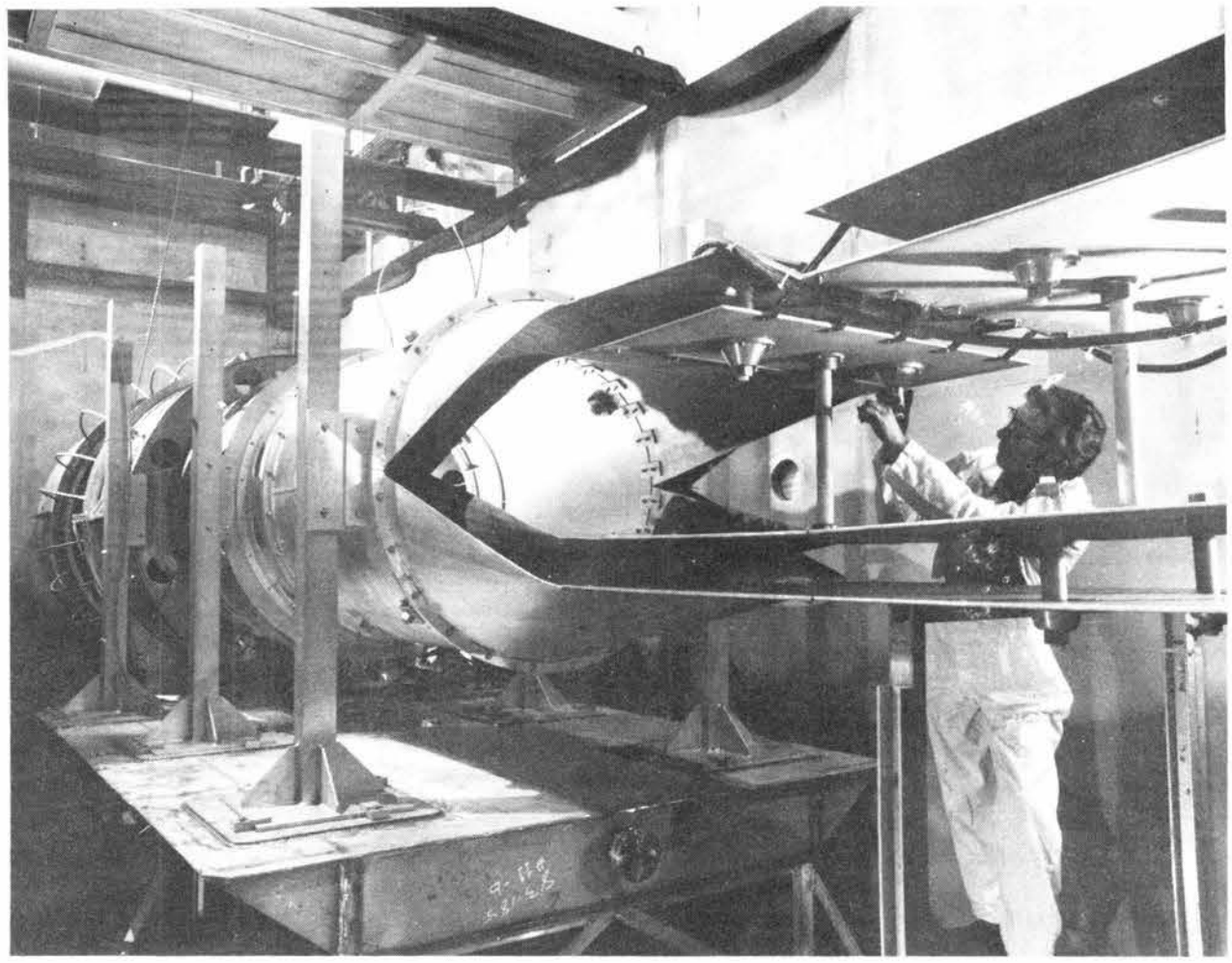
All 36 accelerator modules will be fired simultaneously, concentrating their pulses of electrical energy at the center of PBFA II. There a plasma-opening switch array will transfer the energy into a circular diode. The diode converts the electromagnetic energy into a beam of lithium ions and focuses the ions onto the target. Ions — atoms with some of their electrons stripped away — deliver their energy efficiently to a target.

Initially, the target will be composed wholly of diagnostic instruments. Eventually, it will be a pellet of deuterium and tritium fuel, heated and compressed by the powerful beam until its atoms fuse and release energy.

This anticipated achievement of controlled thermonuclear fusion — the same process that powers the sun — in the laboratory is an essential step toward the ultimate goal: building fusion power plants that would use this same process, repeated many times a second, to produce heat to generate electricity. That goal is not likely to be achieved until well into the 21st century.

Dozens of Sandians have contributed to the design and testing of the Demon module for PBFA II. Among them: Tom Martin, manager of Pulsed Power Systems Department 1250; Bobby Turman, supervisor of Pulsed Power Research Division 1252; Gene Neau (1252), design of the pulse-compression section; Russ Humphreys, Jay Penn (both 1252), and Jerry Cap (1251), development of the gas switch; Johann Seaman (1252), director of the Demon test facility; Darrell Green, Jeff Christofferson, Greg Mann, David Mares (all 1252), Guy Donovan, and Zeke Ziska (both 1254), test

(Continued on Page Four)



DARRELL GREEN (1252) works on the pulse-forming lines on Demon, which was recently qualified for PBFA ... a series of tests in Area IV. Demon is the first of 36 identical modules that will power PBFA II.

Focusing 'Scale Up' Works

tively charged cathode. Without this mesh, electrons were being emitted from edges of the metal cathode rings to form an uneven electric field. The ions that accelerated off the positively charged anode were following this electric field to the cathodes rather than aiming toward a focus between the cathode plates.

John discovered that a transparent plastic mesh connecting the metal cathodes allows the electrons to be emitted uniformly and form a virtual cathode fast enough for the 40-billionth-of-a-second ion pulse to shoot forward as needed. This greatly assisted beam aiming.

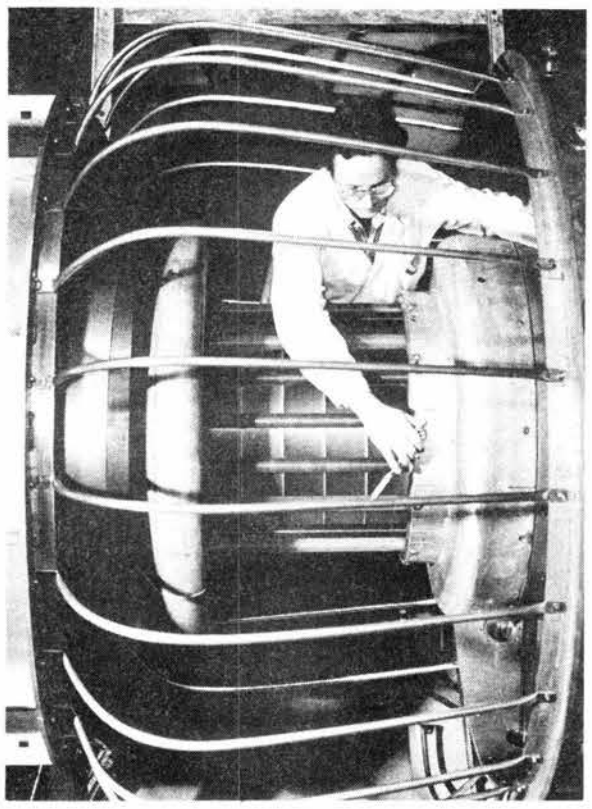
He also discoverd that a second mesh inserted behind the cathode in the area where the beam propagates across a strong magnetic field toward the central target aids the transport process. This second mesh forms a cylindrical surface of equal electric potential that shorts out electrostatic fields that were causing the beam to defocus.

This double-mesh arrangement dramatically increased the ion power density on target.

Another development now underway is to pre-ionize the anode by flooding it with extreme ultraviolet (XUV) radiation just before the electrical pulse reaches it. This XUV illumination creates a uniform plasma layer above the anode surface that can emit an ion beam immediately when the power pulse is applied.

This preparation of the ions in advance, as shown in PBFA I experiments conducted by Joe Woodworth (1244), enables peak power to occur at nearly the same instant as peak voltage. Before, peak power came when the voltage had fallen to 60 percent of its peak. This improved performance has resulted in a 50 percent increase in energy coupled to the diode.

The research team that achieved the new focusing results was led by John, chief theorist Tom Mehlhorn (1265), and diagnostics chief Carlos Ruiz (1264), with essential contributions in diagnostics from Ray Leeper (1234).



JEFF CHRISTOFFERSON of K-Tech services the world's highest voltage, low jitter gas switch, part of the Demon (short for demonstration) module that will be used in PBFA II. The laser-triggered switches synchronize all modules to make 36 generators act as one. The switch (developed by Rich Adams, Joe Woodworth, Charles Frost, and Roy Hamil, all 1244, and Bob Turman, Russ Humphreys, and Jay Penn, all 1252) represents a major advance in pulsed power technology.

Continued from Page Three

Demon Passes Tests

crew for the Demon tests; Larry Schneider and Tom Woolston (both 1251), design of the Marx generator, Mike Wilson (1251), design of the firing system and high-voltage switching system; Ed Constantineau (1251), design of the work platforms; Duane Burgeson (1251), design of the insulating fluids supply and processing system; Keith Tolk (1251), design of the Demon tank; and Bert Arnold (1251), manufacturing liaison.

Ions vs. Lasers

For Fusion, Light Ions Look Good

According to Don Cook, manager of Fusion Research Department 1260, there are essentially four candidate drivers for inertial confinement fusion: light ions, heavy ions, krypton fluoride lasers, and neodymium-glass lasers. (Free-electron lasers are a less-well-developed possibililty.)

"Looking ahead to a future reactor," says Don, "the important things for a reactor driver are cost, efficiency, ability to couple the beam to matter (fuel pellets), and ability to operate repetitively."

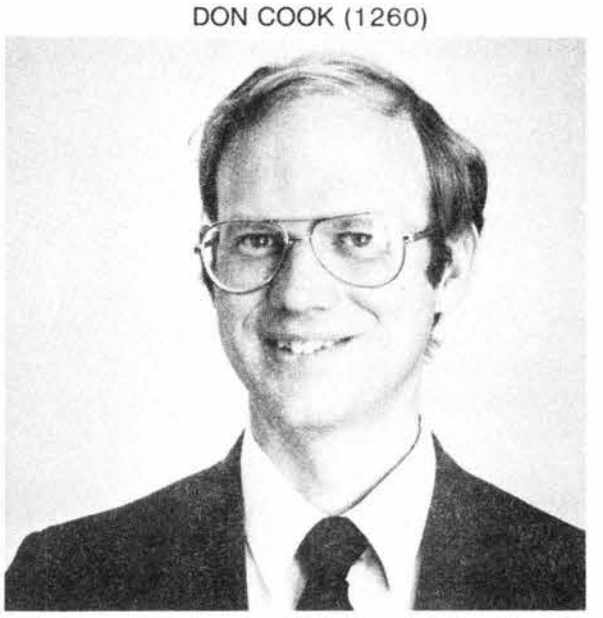
Sandia's approach — light ions — fares well on all counts.

Costs are usually expressed as cost of the total system per joule of energy delivered on target. (A million joules is considered necessary for fusion ignition.) "For light ions, we think the best cost necessary for a repetitive accelerator is $50 to $80 per joule, although it might be as low as $30," says Don. "For heavy ions and all other drivers the *best* goal for the future is a cost below $200 per joule. They are way above that now."

Ions also have an enormous advantag in efficiency. For example, only 0.2 percent of the energy used in a glass laser ICF system is carried by the laser beam. The figure for ions is at 10 percent or so — a fifty-fold advantage. "For reactors, the efficiency of both light and heavy ion drivers is expected to be above 20 percent," says Don. "KrF lasers expect to offer between 3 and 10 percent, and a typical figure is 5 percent. With glass lasers, the hope is eventually to be at 1 percent — but they're only at a fifth of that now."

Ion beams are ahead in coupling energy onto the target too. Ions deposit their energy in a classical, well-understood manner, analogous to the collision of billiard balls. With lasers, some of the energy preheats the pellet, interfering with the pellet compression process. The problems can be reduced by using shorter laser wavelengths, but at shorter wavelengths the survivability of the optical systems becomes a problem.

DON COOK (1260)



PACE VANDEVENDER (1200)

Traditionally, the Achilles heel of light ions was thought to be focusing. An advantage of lasers is that their energy is easily focused onto the small fuel pellets used in fusion. Light ions tend not to be easily focused because of the repulsive interactions of their charge. Thus, research in light ions has concentrated on the focusing, and Sandia has made some major advances in that area (see related stories).

Repetitive operation was also once seen as a drawback to fusion with light ions. No more. "Light ions can now be made repetitive," says Don. Magnetic switches operate very efficiently and do not generate shockwaves, and laser-triggered switches provide very good synchronization. These improvements now make ion accelerators capable of repetitive operation (although the ion diode is still a weak spot for repetition). KrF lasers can probably be made reasonably repetitive, says Don. Solid state crystal lasers have been proposed for repetitive operation but face formidable problems in heat transfer without optical distortion.

Particle accelerators like PBFA II are relatively simple machines compared with lasers — a factor that greatly reduces costs. PBFA II will cost about $48 million when complete, approximately one-fourth the cost of the largest ICF laser. It will deliver between 1 and 2 million joules on target, more than 20 times the on-target energy of the laser system.

See "Sandia Fusion Research, Page Five"

Magnets and MITLS

Turning an Annoyance into an Aid

Any time you have a flow of electrons, as in an electric current, you have a magnetic field also. The field runs around the current flow like an invisible wrapping. It can act as a barrier to the free electrons that make up the electric current, or it can trap them within its field lines.

In Sandia's high-current pulsed power machines, magnetic fields can be either an annoyance or a boon. With characteristic inventiveness, the Area IV crew is making sure that the fields work to the benefit of research and not to its detriment.

In PBFA I and some other machines, magnetically insulated transmission lines — MITLS — move electrical energy from pulse-forming lines to the diode, employing two main conductors that are separated by a vacuum. The flow of current in the surface of the conductors creates a magnetic field within the vacuum. This flow provides an insulating barrier that confines the electrons close to the negative electrode.

In the Applied Magnetic Field diode (called the Applied B diode for short) chosen for use in the PBFA machines (LAB NEWS, March 2, 1984), a so-called virtual cathode is created by electrons that are caught in the field lines from an electromagnet. The virtual cathode performs the vital job of attracting and accelerating ions, impelling them from the anode surface to the fusion target.

WIPP Experiments Turned On

Comprehensive Studies Underway

The most comprehensive full scale rock mechanics studies ever undertaken are starting in the salt deep in the WIPP (Waste Isolation Pilot Plant) near Carlsbad. Next week, as power to electrically heated canisters is turned on, more than 1100 data channels will measure the effects of heating the salt. The data will come from sensors that are recording information from the first of several large scale heated room experiments. Instruments will measure the displacement, strain, stress, and temperature from experiments buried in chambers 2150 feet under the surface in a salt formation destined for disposal of transuranic radioactive waste.

Sandians of Waste Management Technology Department 6330 under Wendell Weart have provided scientific direction for the WIPP program since its inception in January 1975. They have performed extensive laboratory studies, issued volumes of site characterization reports, published environmental impact statements, performed the conceptual design, and projected (through computer analyses) the structural behavior for the entire 25-year operational life of WIPP — and beyond, to, say, 10,000 years.

"Turning on the *in situ* experiments puts us in the real world," Wendell says. "We are now looking at a real environment, real geometries, and real time. These experiments — some of them scheduled to continue for many years — will confirm judgments based on lab experiments, field tests conducted in potash and salt mines, and computer analyses. We will examine and validate those premises."

Construction of many of the major facilities — experiment rooms, maintenance shops and warehouses, head

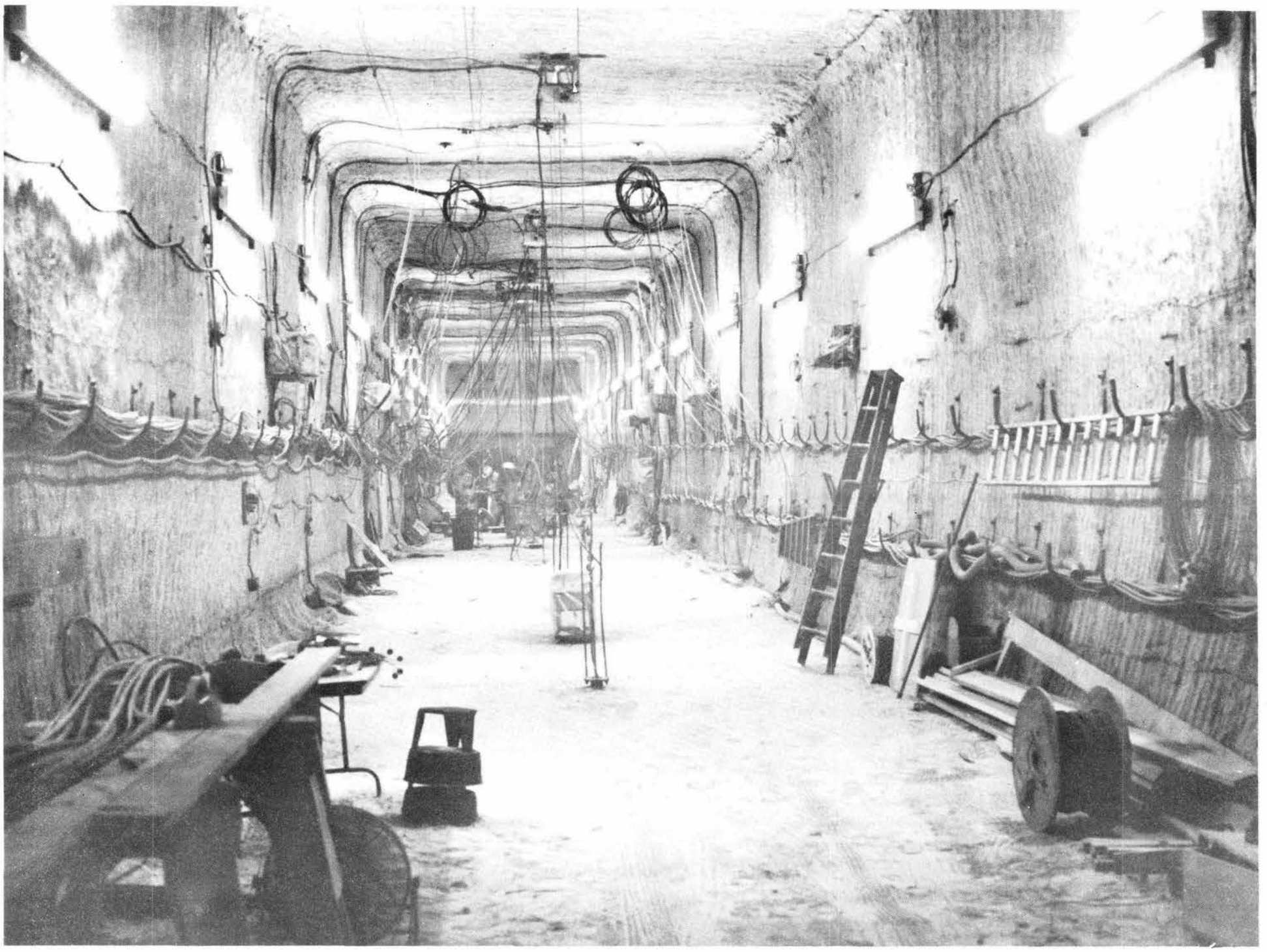
(Continued Next Page)

AERIAL PHOTO of the WIPP site shows surface facilities under construction. Tower at center right is the head frame over the personnel and salt-handling shaft that extends down some 2150 feet to a complex of tunnels and chambers in a geologic formation of salt, the future destination of radioactive waste.

LAB NEWS

VOL. 37 NO. 7 SANDIA NATIONAL LABORATORIES APRIL 12, 1985

SANDIA'S BOARD OF DIRECTORS met in Albuquerque last week. The group attended extensive briefings by several Sandians and, according to President Dacey, were impressed with Sandia's work. Left photo, from left: Donald Procknow, vice-chairman of the board, AT&T Technologies, Inc.; Ian Ross, president, AT&T Bell Laboratories; John Zeglis, executive vice-president and general counsel, AT&T Technologies, Inc.; and President George Dacey. Right photo: Tom Cook, executive vice-president 20; Thomas Thomsen, president, AT&T Technology Systems Group, AT&T Technologies, Inc.; and Lee Bray, executive vice-president 30. The remaining board member, Larry Lemasters, executive vice-president, AT&T Bell Laboratories, was unable to attend the meeting.



LARGE MINED ROOM under the surface at the WIPP site is typical of those housing Sandia *in situ* rock mechanics experiments. A comprehensive program is underway in rock mechanics, waste package, and plugging and sealing phenomena. Some 5000 data channels from extensive sensor and instrumentation arrays will provide information. The first of these were installed and activated in 1984. Heater power was turned on this week.

Continued . . .

Full-Scale WIPP Experiments Underway

frame and hoist house, three shafts down to more than three miles of underground tunnels and chambers — is complete. The remainder of the major surface facilities are under construction, and WIPP will be completed in December 1986. The first radioactive material will arrive in October 1988. the intervening 22 months will be devoted to "cold" operations testing and demonstration of waste retrievability by the operating contractor, Westinghouse.

Sandia is conducting *in situ* experiments in three major areas: thermal/structural interactions (principal investigator, Darrell Munson); waste package performance and near-field effects such as brine migration (principal investigators, Marty Molecke and Jim Nowak), and plugging and sealing (principal investigator, John Stormont). Chris Christensen is underground experimental coordinator. Rudy Matalucci is the experiment design coordinator working with Bechtel, WIPP architect-engineering firm. All are in Experimental Programs Division 6332 under Lynn Tyler.

The thermal/structural interactions experiments will measure precisely the salt formation's behavior as it reacts to the heat from the simulated waste canisters. Even though the crystalline salt will safely support mining of tunnels and chambers, it is a "plastic" medium — over time the salt will creep and deform to fill all voids.

Canisters containing calrod heaters will simulate defense high-level radioactive waste, generate temperatures up to 200°C, and accelerate creep mechanisms. To simulate actual waste canister thermal characteristics, 10-foot long canisters containing large calrod heaters have been buried in the floor of the salt chambers. In one experiment, involving three rooms (each 18 feet high, 18 feet wide, and 300 feet long) and designed to continue three years, 58 heaters will raise the surrouding large volume of salt to temperatures up to 62°C. More than 1700 instruments will record the experimental conditions.

Waste package experiments will measure interactions with containers for both high-level and transuranic (contact-handled and remote handled) waste generated by the nation's defense programs.

Two canister designs for high-level waste along with various backfill materials are being tested. Canisters fabricated from TiCode 12 (a titanium alloy extensively evaluated by Divisions 1841, 1832, and 8314), and others from stainless steel with a thick mild steel overpack, are positioned in various emplacements and backfilled with either crushed salt or a bentonite/crushed salt combination. Bentonite is a clay-like material of low permeabililty and high absorption for many elements; it acts to impede water permeatin and transport of isotopes. Corrosion of the canister materials will be evaluated along with all other factors affecting the emplacement.

Other containers — 55-gallon drums designed for disposal of contact-handled transuranic waste — will be placed in brine pits, in dry chambers, and in chambers periodically sprayed with water. In several of these tests, elevated temperatures will be used to accelerate reactions and simulate long periods of time in these environments.

In another experiment a large pillar of salt, 36 feet in diameter and 10 feet high, has been isolated in a cylindrical room. The overburden on this pillar (typical of those left in large chambers during mining operations to support the ceiling) is 2200 pounds per square inch. A blanket electric heater wrapped completely around the pillar will raise its average temperature to 70°C over a period of three years while the room

(Continued Next Page)

temperature reaches 40°C. Data from this experiment will — for the first time — compare directly, without geometric approximations, to the two-dimensional computer code calculations used in WIPP thermal/structural modeling.

Considerable attention is being given to experiments with seals and plugs for man-made penetrations (boreholes, shafts, tunnels) to determine their short- and long-term isolation characteristics. Ultimately, the effectiveness of waste isolation is just that — how well the repository is isolated from migration of ground water through the site and through time. Instrumentation is measuring compaction, permeability, strain, and temperature.

All instruments and sensors are connected by hardwire to underground sheds where data are formatted and sent over a few cables to a central data acquistion system (MOD COMP computer) on the surface. Monitoring and recording functions of the instrumentation are automated; however, some visual readings are required. More than 5000 data channels will be required when all experiments are on line.

"These are comprehensive experiments," Wendell emphasizes, "designed to provide an extensive data base. The data will be used to validate our computer codes and provide confidence in predicting long term — up to 10,000 years — repository behavior and its effectiveness in isolating radioactivity from the biosphere."

WIPP Project Participants

The WIPP (Waste Isolation Pilot Plant) is a DOE facility with a project office under W.R. Cooper located in Carlsbad. The WIPP project office reports to Denny Krenz, DOE/AL Office of Projects and Energy Programs.

Sandia provides scientific support to WIPP. Wendell Weart (6330) is Sandia project manager. The Field Engineering Directorate 7100 has provided fielding support under the leadership of Jim McIlmoyle (7125).

Other organizations contributing to the WIPP *in situ* program include Applied Mechanical Division I 1521 under Ray Krieg and the Geomechanics Division 1542 under Barry Butcher.

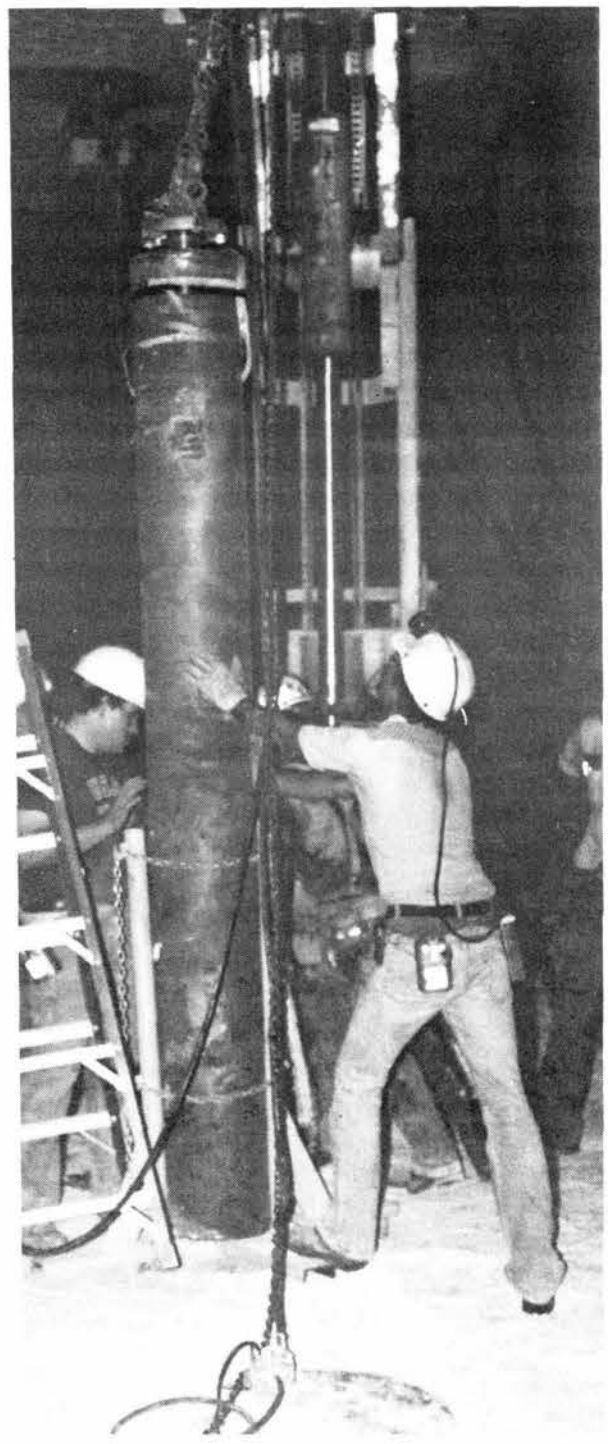
Bechtel Corporation is architect/engineer contractor for WIPP, responsible for design and inspection services.

Westinghouse has been the Technical Support Contractor and on April 1 became the Operating Contractor. Operations at WIPP will require some 300 employees at the site when WIPP is operational starting in late 1988.

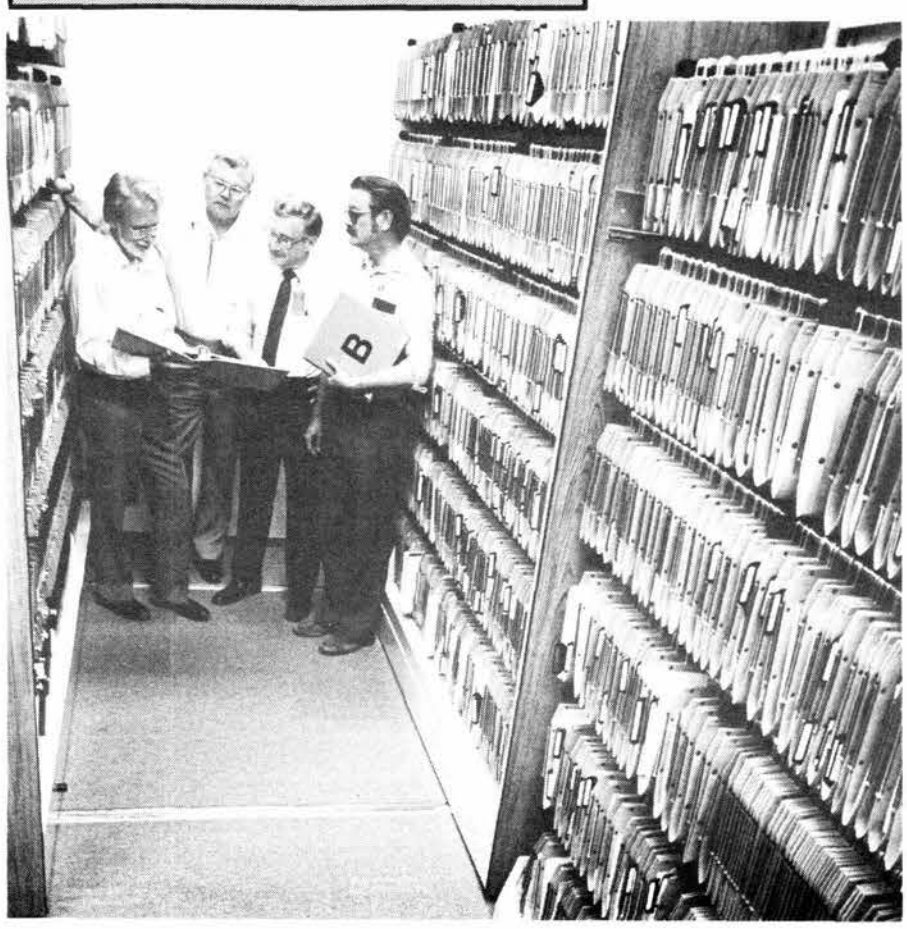
The U.S. Army Corps of Engineers is responsible for managing WIPP construction for DOE.

WIPP Mileposts

Jan. 1975	ERDA (Energy Research and Development Administration) authorizes Sandia to start preliminary WIPP study.
June 1977	Sandia completes conceptual design of WIPP.
Dec. 1978	Site characterization report completed.
April 1979	Sandia-prepared draft environmental impact statement released.
Oct. 1980	Final environmental impact statement published.
March 1982	Comprehensive *in situ* R&D program developed.
July 1983	DOE approval to proceed with full-scale WIPP construction.
Late 1984	National Academy of Science panel report supports acceptability of WIPP site.
Feb. 1985	Construction of experimental underground facility completed.
April 1985	*In situ* experiments in place and heaters operating in first experimental heated room.
Dec. 1986	Construction complete.
Oct. 1988	WIPP operational. First transuranic waste arrives. First phase of *in situ* experiments completed and evaluated.
Sept. 1989	Experiments using defense high level waste initiated.



LARGE ELECTRIC HEATER is lowered into an experimental emplacement in one of the WIPP underground chambers. This heater generates temperatures up to 65°C in the salt, simulating thermal characteristics of a canister containing defense high level radioactive waste. Other canisters will provide "overtest" temperatures in the salt of 200°C. Extensive instrumentation records the response of the salt formation and the waste package installations.



A LITTLE CROWDED, but the mass of documents produced by Sandia for the WIPP project requires a lot of space in the WIPP library in Bldg. 823. In addition to several hundred formal reports, more than 150 QA documents, information memos, experiment data, geophysical survey results, and well logging records are included. From left are Jim Nowak (6332), Wendell Weart (6330), Lynn Tyler (6332), and Darrell Munson (6332).

Antojitos

Pushing a Dream into Reality I accidentally met John Maenchen (as in "mention") last week as we were fighting time to put out this special issue on pulsed power fusion. If his name looks familiar, it's because you read the article that begins on the front page -- he's playing a key role in the "scale up" work being done in Area IV. One of the characteristics of John and of many of the other pulsed power people I've met — a characteristic that's difficult to work into a tech story -- is exuberance. Here at the paper, we get a little jaded sometimes -- we work with bright, dedicated engineers and scientists and their experiments and discoveries week after week. Most tend to be a bit, shall we say, matter-of-fact about their work.

It was refreshing to run into John. He shared some of the frustrations as well as the fascination of working in a field that's truly a frontier. "Everybody else at Sandia has to worry about building reliable systems," he pointed out. "We don't. We can't. We have no such constraints here. We have the opportunity to take big risks. And we make lots of mistakes, but we also learn a lot -- and fast.

"It's exciting. I can't think of anything I'd rather be doing." Okay, John has been here only a year or so. He's done some good work. Who wouldn't be excited? But I also spent a couple of hours with Tom Martin, who's been around pulsed power fusion since 1965. He's still exuberant -- to Tom, fusion's not a matter any more of whether, it's a matter of when. And of what: what then? What are the implications for civilization when even terawatts (trillions of watts) are not sufficient to quantify the energies to be harnessed? Tom taught me a new word and gave me cause to remember it. It's petawatts — quadrillions of watts.

But Tom also looks back, and with a kind of reverence for the pioneers in the pulsed power field. He mentions two Germans, Braseh and Lange, who in 1930 built a crude vacuum tube and applied a voltage surge to it. The discharge tube practically exploded on each surge so it had to be cleaned out and reassembled often. (Tom identifies with that.) Two years later the two stretched an insulated cable between two peaks in the Alps (apparently without the help of either Field Test or Plant Engineering) and suspended from it a conducting cable supporting a terminal; a grounded terminal sat on the valley floor. During thunderstorms the system produced sparks several hundred feet long. (Lots of potential there, in more ways than one.) They planned to install a discharge tube to accelerate particles, but their experiments were abandoned when Lange was killed. Yes, Tom's been around quite a while, but he hasn't lost the ability to be awed by audacity in challenging Nature. •BH

LAB NEWS

Published Fortnightly on Fridays

SANDIA NATIONAL LABORATORIES

An Equal Opportunity Employer

ALBUQUERQUE, NEW MEXICO
LIVERMORE, CALIFORNIA
TONOPAH, NEVADA
AMARILLO, TEXAS

Sandia National Laboratories is operated by Sandia Corporation, a subsidiary of AT&T Technologies, Inc., and a prime contractor to the U.S. Department of Energy.

BRUCE HAWKINSON, Editor
DON GRAHAM, Assistant Editor
NORMA TAYLOR, Writer
LOUIS ERNE, Photographer
GERSE MARTINEZ, Assistant Photographer
BARRY SCHRADER, Livermore Reporter

Member, International Association of Business Communicators

Retiree Picnic

The annual retiree picnic at Sandia Albuquerque is scheduled for Thursday, May 23. Invitations will be mailed to all retirees later this month.

Build a Distorted Room, a Sound Mirror

Recreational, Educational Exhibit Needs Help

An outdoor physics playground. An antigravity mirror. Pendulum swings. An echo tube. A drawing machine.

Those are some of the hands-on delights planned by the NM Academy of Science's upcoming indoor and outdoor exhibit at the Museum of Albuquerque. The exhibit opens June 1 — and much remains to be done by then.

The various "hard science toys" will teach while they entertain. And they'll provide concrete examples of the San Francisco Exploratorium-type museum the Academy hopes to build someday.

In the meantime, Dave Ginley (1154) needs volunteers to help construct the exhibit. If you can dig holes, pound nails, finish concrete, do drafting, or whatever, your help is appreciated. Dave hopes to form some weekend work parties over the next six weeks. And retirees who could work during the week are also welcome. Call Dave on 4-8863 or 296-0005 if you can help.

Several Sandians are members of the Academy and active in the Science Museum effort; Janda Panitz (1834) is next year's president.

feedback

Q. What is the procedure for an uncleared SNL employee who wants to stay after 5:30 p.m. (I work in 800 and they lock the building then), or who wants to work weekends? At present, I think you have to arrange for an escort or take your work home!

A. If you feel the need to stay late or work a Saturday, have your supervisor contact the on-duty lieutenant, who will try to arrange access on an "as needed" basis. Initial arrangements should indicate arrival as well as departure times and gates/doors to be used.

C.L. Brumfield - 3400

The present system for cash on Employee's Expense Vouchers calls for the voucher to be:

1. *taken to Finance*
2. *signed in front of the teller upon receipt of funds*
3. *returned to the secretary (who retains one copy)*
4. *sent to Vouchering in the mail*
5. *delivered by the Mail room to Vouchering.*

The procedure could be simplified if Finance would return the last copy of the voucher with the funds to the individual and place the rest of the voucher copies in a stack for Vouchering to pick up once a day. This would eliminate steps 3 through 5, and the possibility of loss of vouchers. The timesaving should be significant.

A. Your suggestion has been investigated and implemented. The Employee's Expense Voucher on which funds are owed to the employee is now sent to Employee Accounting Division 152 by Financial Division 4021. Hand-carrying of forms between these organizations takes place on a regular basis during the day.

Your suggestion will result in these vouchers being treated like the new Reimbursement Voucher (SF 4601-D), which was introduced in early October. In both cases, the finance teller will reimburse the employee, the employee will sign for the funds received, the teller will give the last copy of the voucher to the employee, and the remaining copies of the voucher will be held for Accounting.

P.M. Stanford - 100

Computing Doesn't Have to be Formidable

SNLL Computer Users' Guide Available

If the number of advance requests is any indication of interest, a new book reaching Sandians at Livermore this month will be second in popularity only to the company phone book.

The new manual, *Introductory Guide to Computing at SNLL,* was the brainchild of the Computer Users' Group and represents the combined efforts of 21 people.

Mim John (8478) chaired the group that assembled the more than 150 pages of useful information for every employee who uses a computer terminal on the Sandia Livermore system. She calls the project "a unique effort in that we pulled in people from all over the Lab, a real cut across the resources of Sandia, to put this manual together.

"We've known for some time that the beginning or infrequent computer user needs help," Mim continues. "We also wanted to inform the specialized user of other resources available in our labwide computer system."

A survey of SNLL employees last December indicated that at least 600 would welcome such a guide. Mim credits the 20 people who did the compilation with her for volunteering many hours of their time to make the guide "an accurate and reasonably complete" document.

The first section of the manual is an overview of the computing facilities available at Sandia. It's followed by a chapter (aimed primarily at users of the Digital VT 100, the most common model on site) on getting started with the terminal.

Another section deals with the VAX system, plus a chapter on the Cray Time-Sharing System (CTSS).

Other sections cover the Central File Storage System, special purpose software, how to write tapes, a glossary, index, and a help directory.

Mim said many users will find the latter the most useful part of the guide. It's a phone directory in front that tells whom to call when in trouble on the terminal.

The guide has a looseleaf format so that additional information and section updates may be added. Bob Tucker of Publications Division 8265 will act as a repository for revision material. Mim encourages readers to make suggestions for future additions and better explanations of the basics where needed.

"Starting to deal with computing at Sandia can be a formidable thing, but it doesn't have to be. Up to now most of us have learned because we've had somebody close by who was willing to help us," Mim says. "We want to stress that this is a users' guide, written by other users, not put together by a computer manufacturer, so we hope it covers the fundamentals helpful to nearly every computer user at Sandia."

Those responsible for producing the manual with Mim are Ron Fugazzi (8025), Roger Everett (8152), Steve Binkley and Vern Gabrielson (both 8233), Hilary Jones, Jim Berry, and Spike Leonard (all 8234), Dona Crawford and Tom Jefferson (both 8235), Len Napolitano (8242), Bill Mason and Sam Paolucci (both 8245), Nancy Hunt and Bob Tucker (both 8265), Paula Neighbors (8274), Terry Lowe (8316), Mike Koszykowski (8343), Ken Marx (8363), Marilyn Hawley and Jim Ringland (both 8478).

The final product arrived from the Government Printing Office late in March with distribution early this month to requesters. Those not already on the distribution list may obtain a copy of the guide by contacting Mim at 2-2049.

LOOKING OVER THE finished computer users' manual with Mim John (8478) are some of the key participants on the manual project (from left): Sam Paolucci (8245), Ken Marx (8363), and Jim Ringland (8478).

SANDIA LIVERMORE NEWS

VOL. 37 NO. 7 SANDIA NATIONAL LABORATORIES APRIL 12, 1985

Take Note

Stanford University recently hosted two Sandia committees for meetings on the future of engineering education. James Gibbons, dean of the College of Engineering at Stanford, led the meetings with the Sandia Education Committee, chaired by Everet Beckner (6000), and the University Programs Education Committee, headed by Dick Schwoebel (1800). The groups also toured Stanford's educational television facilities and the recently completed Center for Integrated Systems.

Congratulations

Debbie Griner (8026) and Dennis Cescolini, married in Hayward, March 28.

Deborah and Randy Christman (8023), a daughter, Annaliese Chantel, March 9.

Chuck and Dawn Tockey (8022), a son, Nicholas Kevin, March 22.

ASTRONAUT SALLY RIDE (left) was the featured attraction at the annual career conference for sixth through 12th grade girls hosted by Chabot College Valley Campus March 16. Judy Knorr (8184) has been on the organizing committee for the "Expanding Your Horizons in Science and Math" for the past five years. Other Sandians participating this year included Marilyn Hawley (8478), Lois Johnston (8444), Terry Schoeppe (8474), Sally Antonchuk (8182), Pam Barr (8363), Carolyn Pura (8164), Karen Scheaffer (8235), Jane Lamph (8163), Sandra Bowers (8184), Karen Siegfriedt (8311), Lynda Hadley (8186), Beth Fuchs, and Noreen Gilbertson (both 8243). Sandia is a co-sponsor of the event.

Sympathy

To Gina Lamons (8180) on the death of her grandmother in Oakland, March 9.

Meet Charlie Hines, AB, BB

Balloon Fiesta Has, Well, Ballooned

Charlie Hines (3154) is president of the 1985 Balloon Fiesta. Re-elected to the post for the fourth time, Charlie also served as the '76, '77 and '78 Fiesta president.

Charlie's life can be divided into two time periods—BB and AB, Before Ballooning and After Ballooning. In the BB segment, his primary interest was community service, which began in 1956 when he was elected to the state legislature to represent his district during 1957-58.

"I was defeated on my re-election bid, and that was the end of my political ambitions," Charlie recalls. "But I did learn how our government operates, and I had the opportunity to meet many people."

He also learned how important volunteers were to many organizations. At that time, he was an active outdoorsman — fishing and hunting. So he joined the Albuquerque Wildlife and Conservation Association and served as its president for three years.

Appointed by Governor Ed Mechem, Charlie next served two years on the State Board of Public Health, an organization that established policy for the state health agencies. Later, Governor Dave Cargo appointed Charlie to the State Parks and Recreation Commission. During his four years as vice-chairman, Charlie helped establish several new state parks, including the botanical and zoological gardens at Carlsbad. The Commission selected sites and approved plans, policies, fees, and personnel to operate the parks.

During the early 70s, Charlie served on the City Parks Planning Board and the City Water Resources Commission.

"The latter appointment was quite a challenge," Charlie says. "We had to find ways of using the water from the recently completed San Juan-Chama diversion project until Albuquerque could use it. For example, we stored some of it at Abiquiu Dam and sold water to farmers and others."

Then began the AB cycle. "In 1972, I went to see the first balloon festival," mused Charlie, as he puffed on his ever-present pipe. "It was held near Coronado Center and there were 15 balloons participating. I thought to myself, 'I've got to get into this!' " He looked around for a ballooning organization and immediately joined the Albuquerque Aerostat Ascension Association — Quad A — and became a balloon chaser.

The next year (1973) the Second Annual and First World Championship Hot Air Balloon Fiesta was held at the State Fairgrounds. Charlie was in charge of chase crews. That was the year that the Tech Area began to sprout balloons. Charlie chuckled as he recalled talking to someone in Security before the event about the possibility of balloons drifting toward Sandia. The answer was "We won't allow it!"

For the 1974 Fiesta, Charlie was in charge of all volunteers—chase crews, transportation, and volunteer field activities.

Up to this point, the Fiesta had been funded by private enterprise. The people concerned went to Mayor Kinney and suggested that the city get involved. They felt the Fiesta was a winner and wanted to keep it in Albuquerque, but they couldn't make any money and couldn't afford to finance it. Mayor Kinney asked 15 people to serve on a commission to handle the Fiesta and to raise money. Charlie was appointed treasurer, and the 1975 Fiesta got underway with an $85,000 budget, contributed by local businesses and by citizens.

In 1976, the commission was incorporated and enlarged to 30 members with a 12-member board of directors. Charlie was elected president of the Fiesta that year. The following two years he served as both president of the Fiesta and chairman of the board of directors. During 1979 and 1980, he continued as chairman of the board, and since 1980, has served as a board member.

The Fiesta has had phenomenal growth in every aspect—from 15 balloons in 1972 to 500 in 1985, from a one-day to a nine-day event that includes horse shows, square dancing, kite flying, radio-controlled planes, parachute jumping teams, aerobatics of the AF Thunderbirds and the Navy's Blue Angels. This year, if plans can be finalized, spectators can watch air races. And all of this has been accomplished without any tax dollars and by volunteers. Perhaps the biggest change has been in the financial area: compare the $85,000 budget that the Fiesta commission worked with in 1975 to last year's budget of $600,000.

The majority of that money comes from sponsorships by businesses. Many of the large contributors are national and international corporations. What do they get for their money? Charlie cited an example: the Canon (cameras) people contributed $30,000 to the 1984 Fiesta. And advertising is what they got—pilots wore sponsor's jackets, balloons flew a banner (15'x21', costing $300 each) with the company name, gondola markers were emblazoned with the company's logo, opening day of the Fiesta was named Canon Day, their logo appeared on all name tags, and Canon sponsored one of the major parties for pilots.

"We have many large sponsors," Charlie added. "Some of the large breweries are always represented, Kodak sponsors some of the races, and the last four years Mazda, U.S.A. provided flags (with their logo) for chase trucks. In addition, last year we had over 100 local sponsors, all of whom contributed $1500 each to have a balloon carry a banner with their name.

"We have to spend a great deal of money in advance of the Fiesta for all the things I've mentioned—jackets, banners, flags, and so on. In addition, we pay for lodging for the pilots, we buy pins, patches, calendars, and programs. This year we have 25 separate committees working to put on the Fiesta.

"The Fiesta is great for the economy of Albuquerque. A 1983 economic impact study reported that during the Fiesta, Albuquerque had *no* rental cars and *no* hotel rooms available and that the event generated $29 million in the city. A representative of Kodak told me that the Fiesta is second only to the Rose Parade in the amount of film sold."

CHARLIE HINES gives a wave as he lifts off in his balloon, "Sunny Honey."

As to the sport itself, Charlie is, logically enough, a fan. He purchased his own balloon about six years ago. He's a licensed commercial pilot and his wife Ginny has a private pilot's license.

"There's a camaraderie in the sport that's unlike any I've seen before," Charlie explains. "The bonds of friendship are strong between balloonists and their chase crews—people we couldn't live without—and among other balloonists. Albuquerque has a balloon population that's fast approaching 250, and worldwide friendships are renewed each year at the Fiesta.

"Ballooning is a friendly sport. It's extremely relaxing and can make you forget any troubles. With our weather, we can fly as many as 40 to 45 weekends out of 52 each year. There are at least two balloon rallies each month that are within driving distance. Balloon pilots can become very skillful at finding the right winds, and there are a lot of serious racers. I've never been that interested in serious racing—I just enjoy the fun of it.

"The bad accidents that occur in ballooning, infrequent as they are, have emphasized safety rules that we all should observe. The biggest danger in ballooning is power lines. We sometimes land in strange places in order to avoid power lines or because of a sudden gust of wind. Then tradition takes over and the champagne comes out to be shared with those who greet us."

That tradition dates back to the early days of ballooning in France. Balloonists would land in a farmer's field and soon be surrounded by a group of frightened, pitchfork-waving farmers who thought the devil had invaded their property. The French pilots decided that offering them champagne could ease the tension. The tradition continues today even though the landing atmosphere is usually much friendlier.

A tradition established by the Fiesta also continues—that of using volunteers. Anyone interested in volunteering can call the Fiesta office. There are openings for everything from stuffing pilot packs to chase crews.

Even AB, Charlie has not given up his many other community activities. Currently he's president of the Bosque Farms Village Library Board and a member of the Planning Committee and the Ordinance Review Committee for the Bosque Farms Village Council.

"I'm busy," he says, "but I'm hooked on ballooning. The Fiesta is the one thing I've been involved with that has no controversy — everyone loves the balloons!"

Fun & Games

Golf—Winners of the recent SGA "Snake Attack Open" played at Cochiti were Darryl Dew (1233) and Jack Marceau (ret.), first flight. Second flight winners were Robert Varga and Richard Harris (both 7542) and third flight went to Dennis Gutierrez (7535) and Marco Holloway (7818).

The next SGA tournament, a two-man scramble event, is scheduled Saturday, April 20, at Los Altos. Darryl Dew has details, 4-6391.

* * *

Running—Honoring National Libraries Week April 14-20, the Second Annual Albuquerque "Jog Your Mind — Run to Your Library" 5K run is scheduled april 13. The run starts at 9 a.m. in front of the UNM Law School Library (1117 Stanford NE), passes Zimmerman Library on the UNM campus, and finishes at Albuquerque's main public library (501 Copper SW).

Organized by the Rio Grande Chapter of the Special Libraries Association, the run raises funds for library programs in the state. Registration starts on the day of the race at 7:30 a.m. in front of the Law School Library. Entry fee is $7. Advance registration costs $5; forms are available at Sandia's Technical Library, the KAFB library, at Albuquerque public libraries, and at sporting good stores.

T-shirts will be given to the first 350 entrants. Ribbons will be awarded in each runner category. For further information, call 268-6300.

* * *

Fitness—A Fun 'n Fitness Day, sponsored by the Medicine/Business Coalition, the City of Albuquerque, and Albuquerque media is planned Sunday, April 21. Walking, running, and biking events are scheduled with a grand prize of a trip to Hawaii to be awarded. More than 100 other prizes will be given away by drawings to participants.

All athletic events start at 2 p.m. and wind up at the Civic Plaza where entertainment — jazzercize demonstrations, yoga, aerobic workouts, karate, and body building — starts at 1 p.m. and continues all afternoon. Refreshments will be available. There'll be clowns, balloons, magicians, and information on wellness.

The events are not competitions. The walk (2.3 miles) starts from UNM's Pit, University and Stadium; the run (2.9 miles) starts at the Hilton; and the bikers (7 miles) leave from the Civic Plaza, pedal to Tingley Beach, and return.

Volunteers are needed to help start the events (they can also participate). Contact Susan Harris (3332), 4-0713. Susan reports that organizations, such as Sandia, are in competition for the greatest number of participants. She urges all Sandians to be part of the day's activities and wear a Sandia T-shirt or an ID tag with the company name.

For additional information, call 345-8618.

* * *

Tennis—The Sandia Tennis Association (STA) opens its active season April 15 with men's/women's singles, men's/women's doubles, and mixed doubles challenge ladders continuing through Oct. 15. Four STA tournaments will be played plus the annual Labor Day tournament sponsored jointly with the Coronado Club. If you'd like to join STA or need information, call Terry Holovka (1250), 292-1233.

STA is also sponsoring tennis beginner/intermediate workshops at the Albuquerque Tennis Complex — beginners on Tuesday, April 23, and intermediates on Thursday, April 25. Cost is $7 per person. For details, call Barbara Yrene, 883-7632.

Voters May Give Fiesta a Home

Cutter Field, between Osuna and Los Angeles, has been the home of the Fiesta for a few years. However, after the Fiesta this year, Oct. 5-13, a new site will have to be found. Albuquerque Gravel Co. has let the Fiesta use Cutter Field at no charge, but the company will soon begin to excavate the property for gravel.

The Los Angeles landfill is an area of 77 acres that has been filled in. The property is owned by the City Refuse Department, which has to sell it in order to purchase another landfill site. They would like to sell it to the City Parks and Recreation Department for $1½ million. Parks and Recreation would let the Fiesta use the area as a permanent launch site and then operate it as a multiple-use facility during the rest of the year. Some of those uses would be additional softball fields and dirt bike raceways.

On Oct. 8, voters will decide the issue in a Municipal Bond election.

VIA — volunteers in action

Here are some current volunteer opportunities for employees, retirees, and family members. If you would like more information, call Karen Shane (4-3268).

ALBUQUERQUE CONVENTION AND VISITORS BUREAU needs volunteers to staff an information office at the airport in the evenings and on weekends. Assignment would be to tout area's attractions to visitors. Orientation and mileage will be provided.

DENNIS CHAVEZ ELEMENTARY SCHOOL needs judges for its science fair on Thursday, April 18, 9-noon.

Events Calendar

April 12-14 — "Flamenco and Classical Español," Isabel Lujan Flamenco Dance Co. and the NM Ballet Co., Fri.-Sat. 8 p.m., Sun. 2 p.m., Albuquerque Little Theatre, 883-6940.

April 12-14 — Albuquerque Artists Assoc. 6th Annual Springtime Exhibition, Ag. Exhibit Hall, State Fairgrounds, Fri. 10-9, Sat. 10-7, Sun. 10-5, 884-8476.

April 12-14 — Antiques Show & Sale, Fri. noon-9 p.m., Sat. noon-8 p.m., Sun. noon-6 p.m., Convention Center, 2nd & Marquette, 268-5122.

April 14 — NMSO Chamber Music Concert, 4 p.m., Keller Hall, UNM.

April 14 — Masterchorale Spring Concert, 7:30 p.m., First United Methodist Church, 4th & Lead, 293-8683.

April 14 — Music at the Museum: Harold Burke (French horn), 3 p.m., Albuquerque Museum.

April 19-20 — NM Symphony Orchestra concert, guest pianist Bryon Janis, guest conductor Enrique Batiz, 8:15 p.m., Popejoy, 842-8565.

April 21 — Albuquerque Youth Symphonies, 7:30 p.m., Popejoy, 277-3131.

April 21 — Movietime at the KiMo — Movies by Great Directors, "La Strada," Federico Fellini (1954), 7 p.m., KiMo.

April 22 — Albuquerque Philharmonic Orchestra Spring Concert, 8:15 p.m., Studio One, KAFB, 266-9353.

April 24-28 — Ice Capades, Tingley Coliseum, State Fairgrounds, 243-3208.

April 26 — Pete Fountain concert, 8 p.m., Popejoy.

April 26 — KiMo Showtime — Queen Ida and her Bon Temps Zydeco Band (blend of blues & French Cajun music), 8 p.m., KiMo.

Retirees Too

AT&T PC 6300 Employee Sales Program Revised

Sandia employees and retirees are eligible to participate in AT&T Information Systems' revised Employee Sales Program for the AT&T PC 6300. Under the revised program, each hardware component and most software is offered at 40 percent off the suggested retail price. Sandians can place a maximum of two orders per year for processors. Peripherals and software may be ordered separately, and there is no limit on the number of orders that can be placed for these items.

Those interested in purchasing an AT&T PC or obtaining information about prices should call Betty Jo Ciesielski on 294-8100. A demonstration of the equipment is available by visiting AT&T Information Systems, 8500 Menaul NE, Suite B345.

Congratulations

Bobby (323) and Debbie Corbell, a son, Andrew Nelson, April 3.

TOM BLEJWAS (6313), JEFF QUINTENZ (1265), LARRY BUXTON (6444), and SCOTT SINNOCK (6315).

Supervisory Appointments

TOM BLEJWAS to supervisor of Geotechnical Projects Division 6313, effective April 1.

Tom joined Sandia's Containment Integrity Division 6442 in June 1980. His primary work has been testing models of nuclear reactor containment buildings.

Tom received his BS in aerospace and mechanical engineering form Princeton, his MS in ME from the University of Southern California, and his PhD in civil engineering from the University of Colorado. He served in the Air Force from 1969-72 as a flight test engineer at Edwards AFB. Tom is a member of ASME. He enjoys skiing and tennis and says he is in his fifth year of a five-year-plan to landscape his backyard. Tom, his wife Charlene, and their two children live in the NE heights.

* * *

JEFF QUINTENZ to supervisor of Pulsed Power Theory Division 1265, effective March 1.

Until his recent promotion, Jeff had been with the Plasma Theory Division 1241 since joining the Labs in September 1975.

He received his BS, MS, and PhD—all in EE—from the University of Arizona. Jeff is a member of the American Physical Society. He enjoys tennis, backpacking, and church activities. He and his wife Dottie have two daughters. They live in NE Albuquerque.

* * *

LARRY BUXTON (DMTS) to supervisor of Thermal/Hydraulic Analysis Division 6444, effective April 1.

Joining the Labs in 1970 as an MTS, Larry was assigned to a weapons effects group working on X-ray vulnerability. In 1975 he joined the reactor safety program where he studied steam explosions. Larry has been with his current division since 1980, working on access and application of thermal/hydraulic codes (e.g., RELAP-TRAC).

Larry received his BS in math and physics from Murray State University (Ky.) and his PhD in nuclear physics from the University of Kentucky. He is a member of the American Nuclear Society and the American Physical Society. Larry enjoys sailing, camping, and microcomputers. He and his wife Phyllis have two children. They live in the University area.

* * *

SCOTT SINNOCK to supervisor of Geoscience Analysis Division 6315, effective April 1.

Since joining the Labs in June 1978, Scott has been with the Nevada Nuclear Waste Storage Investigations (NNWSI) Projects Department 6310. His first assignment was with the Technical Overview Division. In 1982 he transferred to the Repository Performance Assessments Division 6312 and, since January of this year when the division was created, he's been with the geoscience analysis group.

Scott received a BA in geology from Indiana University, and his MS and PhD, both in geomorphology, from Purdue University. He enjoys woodworking and home improvement projects. Scott and his wife Susie have a seven-month-old daughter. They live on the west mesa in Taylor Ranch.

LAURA BROWN (2335) served as a judge at the Regional Science Fair held recently at UNM. She judged 31 exhibits in the Junior (6th-8th grades) Behavioral Science Projects, and presented three special awards. This was her first experience as a volunteer judge, but she says she was so impressed with the quality of the exhibits and the enthusiasm of the students that she's eager to volunteer again.

JIM DAY (3322), Sandia's Medical Technologist, was one of the volunteers from the medical profession who participated in the recent Health Fair New Mexico. Jim put in a long day at the Convention Center drawing blood samples for chemistry analysis in the general health assessment and coronary risk evaluations.

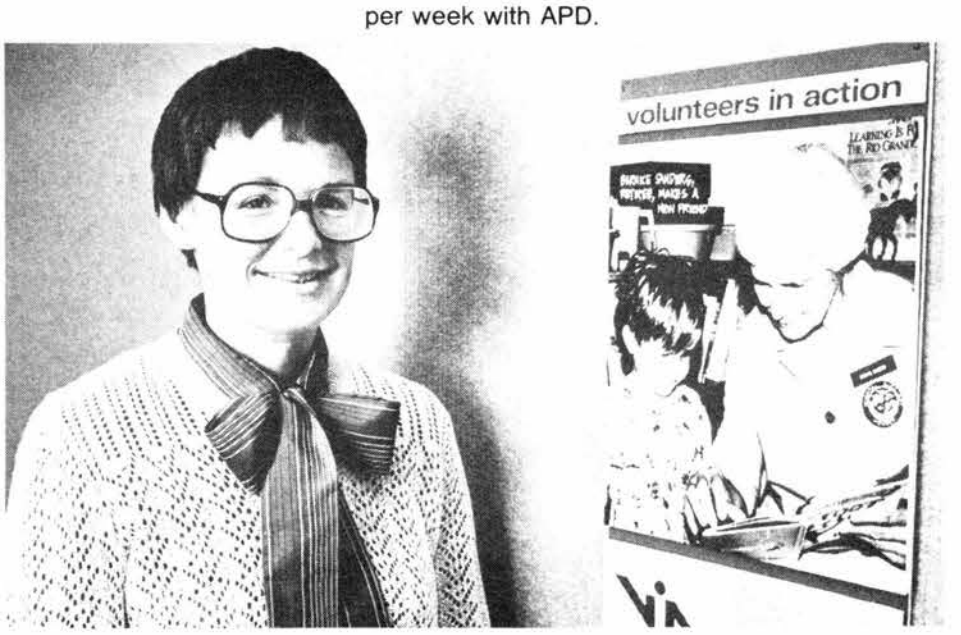
Volunteers in Action

National Volunteer Week

President Reagan has designated April 22-28 National Volunteer Week, a time to celebrate voluntarism. Volunteers in Action also congratulates all Sandia volunteers. Those pictured here are a sample of many Sandians and their varied interests in volunteer work.

KENT PARSONS (2310) is the recipient of the first annual award as the APD Reserve Officer of the Year. Kent has been a member of the Police Reserve Corps for 10 years. Reservists are trained at the Police Academy (225 hours of classroom instruction) and on-the-job (80 hours). All cadets receive expert instruction on firearms and defensive tactics. Kent serves one full shift per week with APD.

FRANK GERSTLE (1845), center, and other team members from the Albuquerque Mountain Rescue Council return to their field headquarters after a night training session. Frank, a member of the volunteer group for 10 years, was recently appointed by Governor Anaya to the State Search & Rescue Review Board for a two-year term.



KAREN SHANE (3163) coordinates Sandia's Volunteers in Action program. Anyone — employees, retirees, and family members — interested in volunteer work can call Karen (4-3268).

Take Note

Ya'akov Eden, dancer, teacher, and workshop leader of Israeli folkdance, will conduct a workshop tomorrow at Carlisle Gym (north of Central on Yale) from 8:45 to 11:30 a.m. ($4, white-soled shoes only). A second session will be offered from 1-5 p.m. ($6), and a review and party at 7 p.m. ($1.50) at the Heights Community Center, 823 Buena Vista SE. Attend any one session or all three sessions ($10/person). For more information call 268-7426.

* * *

The 21st annual Symposium of the NM Chapter, American Vacuum Society will be held April 23-25 at the Albuquerque Hilton. The technical meetings will include sessions on surface science, thin films, and general vacuum technology. The keynote address, "Technological Forecasting," will be given at 9:30 a.m. on April 23 by Hans Mark, Chancellor of the University of Texas.

Some openings are still available for the short course program; call Ray Berg (2534), 4-1668, for information. The Vendor Exhibit on vacuum equipment will include about 40 exhibitors.

Registration fee for the technical program is $50 for the full three-day meeting or $20 for one-day attendees. Register at the meeting or contact Henry Peebles (1831), Symposium Chairman, on 4-1647.

* * *

Jerry Jercinovic (3440) and Margaret Carroll (7861) are members of the R&D Executive Committee of the National Safety Council. The 60-member committee met in Santa Fe March 25-29. The agenda included seminars and tours at LANL and Sandia, and a visit to the Very Large Array Radio Telescope installation near Socorro. Objectives of the committee are to study, identify, communicate, and develop solutions to occupational safety and health problems associated with R&D. Safety topics discussed at the meeting included remote handling, robotics, laser fusion, high voltage training, and fire problems in anechoic chambers.

* * *

This month ASME offers a two-evening seminar, "Starting Your Own Business." Designed as a basic "how to" course, the discussions will cover preparation and filing of incorporation papers and other required government forms; formulating and implementing a business plan; securing capital, facilities, personnel, materials, and other resources; accounting for cash management; and other general start-up activities. The course instructor is international management consultant Harley Swink. The seminars will be held April 15 and 18, from 6:30 to 9:30 p.m. in Bldg. 815. Course fee is $10. ASME members and nonmembers are invited to attend.

* * *

"Applications and Techniques of Modern Spectrochemistry" is the title of a conference to be held in the Technology Transfer Center on May 13-14, followed by a tour of the chemistry facilities at Sandia on May 15. Co-sponsors of the conference are the Society for Applied Spectroscopy, Laser Institute of America, SNLA, UNM, and NMSU. Topics to be covered include spectrochemical research and new techniques that could have spectrochemical applications; special emphasis will be on atomic spectroscopy, laser spectroscopy, and infrared spectroscopy. Invited speakers include Gary Hieftje (U. Ind.), Bonner Denton (U. Ariz.), and Alex Sheeline (U. Ill.). Pre-registration deadline is May 7. Papers describing original research are solicited for a contributed poster session; abstracts are due May 1. For more information contact Suzanne Weissman (1821), 6-0820, or Eva Duran (1821), 4-4070.

* * *

Sandia is hosting the annual DOE/contractors Automated Office Support Systems (AOSS) conference at the Marriott Hotel on April 24-26. The AOSS conference agenda covers a wide variety of office automation topics presented by speakers from many sites within the DOE/contractors complex. If you are interested in attending or desire additional information, please contact Loraine McCutcheon on 4-8264 or Mike Robles (both 2613) on 4-5905.

* * *

A "Science Fiction Sunday" is scheduled by the Friends of the Albuquerque Public Library on Sunday, April 21. Science fiction writers Steve Donaldson, Fred Saberhagen, and Susie Charnes will discuss their work. In addition, storytelling for little ones and a panel discussion for teenagers are planned. The event starts at 2 p.m. at Botts Hall (the old Public Library) at Central and Edith. Admission is free.

* * *

Albuquerque will join the nation in observing Keep America Beautiful Week April 21-27, reports T.A. Allen (7484), a member of the Albuquerque Clean City Committee. T.A. says a number of special events are being planned along with special projects of Neighborhood Associations. Grocers and other businesses will offer money-saving discounts on cleaning materials that week while contractors and builders will volunteer crews and equipment to remove heavy litter from empty lots. City crews will have special pickup schedules. Other events will be announced.

* * *

WWII and modern military aircraft will be on display at KAFB on Friday, April 19, as part of the 43rd Annual Reunion of the Doolittle Tokyo Raiders. The exhibit will show equivalent types of aircraft in use in 1942 and in active use today. The public is invited to attend the air show between 2 and 3:30 p.m. Entrance to the show is through the Truman and Carlisle Gates, and the route to the parking area will be marked. The Doolittle Raiders attending the reunion will be at the air show.

A B-25 Mitchell bomber, the type the Doolittle Raiders flew off the aircraft carrier U.S.S. Hornet to bomb Japanese cities on April 18, 1942, will be the star of the air show. Also on display will be a replica of Japanese Val dive bomber, a Catalina flying boat, a C-46 transport, a J-3 Piper Cub, and a N2S3 Stearman biplane from the WWII era. Modern aircraft on exhibit include the C-130 Hercules transport, the T-34 trainer, the HH-3 Jolly Green Giant and HH-53 Super Jolly Green Giant helicopters, and a Vought A-7D Corsair II fighter bomber.

Scientists and Lawyers in Same Boat — Rowing in Opposite Directions

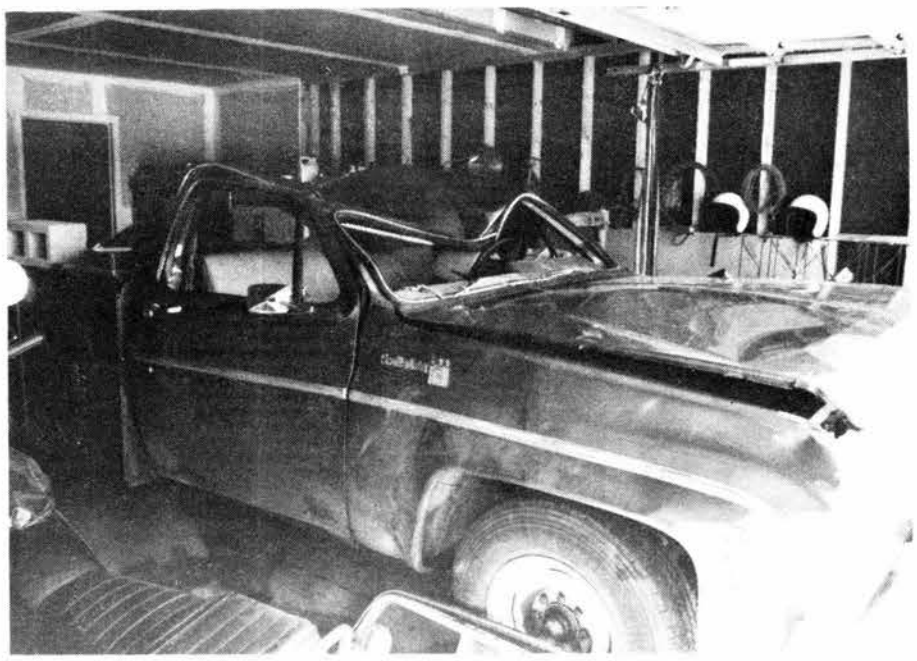
. . . " 'Doing one's job honestly' has different meanings in different concrete circumstances. By way of example, lawyers are obliged to do their jobs honestly and to be intellectually rigorous . . . 'Doing one's job honestly' in the law requires that lawyers do everything possible for their clients, even to the extreme of deliberately obscuring or concealing evidence prejudicial to the cause of the client . . . . Although both scientists and lawyers try to persuade juries of their peers of the validity of their views, the norm of 'doing one's job honestly' and living up to the highest standards in different professions can call for diametrically opposed behaviors — that is, for example, for concealment by lawyers and disclosure by scientists."

Harriet Zuckerman in
Science, Technology, & Human Values

AMERICAN LEGION'S top state award for the employment of veterans was presented to Sandia by Bob Durand (3741), a member of the American Legion National Executive Committee. Accepting the award for Sandia were Lee Bray, executive vice-president 30 (right), and Ray Powell, recently retired administration vice-president 3000.

Welcome

Albuquerque
Robert Davis (2641)
California
Thomas Flynn (1623)
Florida
Michael Bauer (324)
Kansas
Tanya Crenshaw (2634)
New Jersey
Vincent Luk (5341)
Ohio
James Hughes (2364)
Marc Polosky (2542)



YOU DON'T NEED SEAT-BELTS when you're driving slow on an almost-deserted rural highway, right? Wrong. Harold Rarrick's (7541) son Shawn was driving his pickup under 40 mph outside Tres Piedras when a gust of wind pushed the truck off the snow-covered road. The truck rolled over one and a half times, but Shawn was unhurt. He released his seat belt, broke a window glass to exit the vehicle, and called Dad for a tow.

UNCLASSIFIED ADVERTISEMENTS • UNCLASSIFIED ADVERTISEMENTS • UNCLASSIFIED ADVERTISEMENTS • UNCLASSIFIED ADVERTISEMENTS

Deadline: Friday noon before week of publication unless changed by holiday. Mail to: Div. 3162.

Ad Rules

1. Limit 20 words, including last name and home phone.
2. Include organization and full name with each ad submission.
3. Submit each ad in writing. No phone-ins.
4. Use 8½ by 11-inch paper.
5. Use separate sheet for each ad category.
6. Type or print ads legibly; use only accepted abbreviations.
7. One ad per issue per category.
8. No more than two insertions of same ad.
9. No "For Rent" ads except for employees on temporary assignments.
10. No commercial ads.
11. For active and retired Sandians and DOE employees only.
12. Housing listed for sale is available for occupancy without regard to race, creed, color, or national origin.

MISCELLANEOUS

SANDIA T-shirts & caps, $7 ea.; small (1" belt) belt buckles, $8; color aerial photos of Labs, $20; hardbacks, paperbacks, new UNM Press books. South Highway 14 Project, LAB NEWS, Bldg. 814.

AQUARIUM, 45-gal., complete w/stand, fish, extras, $175. Barrows, 296-9775.

HUTCH, dark walnut, 40"x72", $125; dining table (42"x58" w/leaf), brown / beige / gold colors, 4 beige vinyl chairs, $75. Wilder, 299-6198.

COUCH, burgundy red cut velvet w/gold leaf design, custom made, $225. Lusader, 298-3469.

REDWOOD planter, 22" high, 22" diameter, used 2 mos., w/plastic liner, $25 OBO. Meyer, 292-8431.

CHEVY 14" rims, Keystone Klassic chrome 14x7 rims & lugs, used 1 month, 4 for $200. Holmes, 292-0898.

SIGMA zoom lens, 100-200, f/4.5 w/Canon FD auto. mount, $90; Heathkit H-11 computer, w/LS1-11 CPU, EIS/FIS, 3 serial boards, LA 36 terminal w/modem, H-19 CRT, $1300. Barnard, 256-7772.

FRIGIDAIRE elec. dryer; 2 ladies bikes; dark green sofa; Barbie dolls; 2 bathroom sinks; pair snow tires, 13". Hayes, 299-1200.

DINING table, solid maple, 6 chairs, $200. McIlroy, 299-4977.

REFRIGERATOR, Sears 19 cu. ft., frost-free, $250. Lukens, 299-1271.

MATTRESS set w/frame, queen size, used 7 mos., $200 OBO. Skinner, 869-6609.

REFRIGERATOR, GE, 2-dr., separate freezer on top, approx. 15 cu. ft., gold color, $90. Bentz, 299-3448.

BUNK BED, 4x4 frame, $50; girls 24" 3-spd. Schwinn, $50; queen sofabed, $75. Kromer, 298-3073.

RADIAL arm saw, Craftsman 10", stand, rollers, accessory kit, extra blade, etc. $275 OBO. Bowland, 256-1861.

MILLWRIGHT, 12" combination square w/protractor central tool #3123, dial indicator kit w/mounting brackets, C.T. #200, micrometer 0-1# C.T.#12RL. Schneider, 897-0565.

NEW camper shell, LWB, dbl. doors, front/side sliding windows, paneled, cabinets, new cost $780, sell $650. Roh, 869-2108.

AIR conditioner, Whirlpool, refrigerated, for window installation, 11K BTU/hr., cools 560 sq. ft., $469 new, sell $200. Swain, 256-1467.

TV stand, all wood, w/shelf for storage or VCR, $35. Burstein, 821-6688 after 5.

TABLE, round, 57", wicker top, wrought iron frame, 6 matching chairs, $55. Rost, 268-2326.

SPALDING golf clubs, First Flight irons, 2 to S.W. regular shafts, D-1, $135. Zownir, 256-3753.

SLIDE magazines for Argus projector, holds 36 slides, $1 ea. Bureta, 292-5421.

SOFA sleeper, queen size, Herculon upholstery, earthtones, $250. Rovang, 298-4570.

POOL table, bumper, $85. Geck, 299-5095.

CAMPER, custom made for 2, 8' slide-in, stove, elec./gas refrig., heater, pressure water, jacks, $2195. Meyer, 296-9066.

DISHWASHER, Sears Kenmore. Harris, 299-4559.

STAINLESS sink, washerless faucet/spray; range hood; wood base kitchen cabinets; remodeling surplus; 30"x80" Herculon sleeper couches, $25 ea. Atkins, 298-5762.

17' WILDERNESS travel trailer, 7K miles, $5K; Reese hitch, $200; Stratford sleep sofa, full size, $250; white French provincial 3-dwr. chest w/bookcase, $125. Pecqueur, 293-7459.

SUNFISH sailboat, 14' w/trailer & cover, $800; pool table w/new gold felt, $400; river raft, $25. Jarrell, 293-9671.

ENCYCLOPEDIA, Comptons by Britanica, new in box, '84 edition, 24 volume, $600, sell for $350; Yamaha piano, 42" high, console, solid walnut, $2000 OBO. Chavez, 881-2711.

AIR conditioner, 3000 CFM window mount, $75 OBO; range hood, $10. Mooney, 299-1774.

6' RIBBON cable w/Centronics 36 pin male connectors on each end, never used, $15. Schubeck, 821-3133.

DOUBLE bed w/frame, $120 OBO; 5-dwr. chest, white. Quintana, 884-2210 after 6.

IBM std. electric typewriter, pica pitch, red color, $175. Moll, 836-5673.

FREEZER, GE, white, 15 cu. ft., $120. Moore, 345-4030.

LADY Benrus watch, 14K white gold case & band studded w/68 diamonds, appraised at $1850. Williams, (1)864-3617.

FURNITURE: Flexsteel 10' tan corner sofa; Drexel DR set w/buffet; kitchen dinette set w/6 chairs. Kepler, 298-5652.

'81 BIC 12' Windsurfer w/north sail & Matlock harness, $500. Smatana, 299-6278.

PICKUP shell for LWB imports, paintable white fiberglass, fastback styling, $200 OBO by April 19. Pfarner, 299-6521.

D-42 Martin guitar w/hard case, left handed, $1400. Perryman, 281-3020.

BASEBALL, mechanical pitching machine, $35. Gallegos, 293-5634.

19 KITCHEN cabinet doors, various sizes, dark oak veneer, w/hardware, $80 for all. Mead, 294-2298.

COFFEE table, modern, mahogany, 4-pedestal, 2-dr. cabinet space, 21x54, $70. Hernandez, 268-5000.

PIANO, Kimball Spinet, recently tuned, $850; violin, full size, bow, case, made in Mittenwald, Germany, $485. Moss, 265-6077 after 5.

TRANSPORTATION

'84 BMW R100 last edition (1 of only 75 made), special paint, windshield, saddlebags. Shane, 294-4920.

'74 SUBARU 1400 DL, 2-dr. sedan, recently overhauled engine, new paint, new radials. Caton, 294-4490.

'76 OLDS Delta 88 4-dr., AC, AM-FM, premium radials, tilt steering, orig. owner, beige, kept in garage. Mills, 299-2130.

'72 CADILLAC Sedan De Ville 4-dr., $1000 OBO; '78 Honda Hawk, 400cc, windshield, trunk, low miles, $700 OBO. Newell, 293-3636.

'76 JEEP Cherokee, std. trans., 77,500 miles, new clutch & starter, $3800. Carlyon, 299-2318.

'84 TOYOTA/Dolphin mini motorhome, extras. Aaron, Box 1580, T or C, NM 87901.

22' STERNCRAFT, 160 HP, Merc I/O, full camper canvas. Patton, 298-9987.

'78 FORD Fiesta, 95K miles, 1 owner, $800. James, 296-3597.

'81 SUZUKI GS450T motorcycle, blue color, $1000. Montano, 881-4669.

'57 CHEVY 2-dr. sedan, 210 model, V8, AT, completely restored. Harris, 865-0140.

'80 FORD Pinto hatchback, 4-spd. manual, AC, 35K miles, NADA retail $2675, sell $2300. Kavet, 299-1793.

'67 VOLKSWAGEN bug, $1200. McConkey, 293-7430.

'81 MERCURY Zephyr, 4-dr., AT, PB, PS, AC, $3200. Ridlon, 298-4729.

'82 PONTIAC Trans Am, red, T-tops, all options, one owner, low miles, book value $10,200, sell for $9500. Pierce, 265-0233, 268-2122.

'72 DART Custom 4-dr., 6, AT, PS, PB, 76K miles, complete maintenance records. Boyd, 298-4712.

'80 YAMAHA 850 Midnight Special motorcycle, shaded half windshield, luggage rack, cruise control, cover, $1600/offer. Parks, 884-7475.

'73 DATSUN 610 SW, std., 100K miles, $900. Kromer, 298-3073.

'76 OLDS 88 Royale, 50K miles, AC, PB, $2250 OBO. Bowland, 256-1861.

'79 SUBARU 4x4 GL wgn., 66K miles, AC, winch, more, $3000 or trade for small truck. Roeschke, 298-0365.

'78 PONTIAC Sunbird, 2-dr., 4-cyl., PS, PB, AC, 39K miles, white w/red interior. Gendreau, 268-3436 after 5.

'72 PORSCHE 911T coupe, AC, 5-spd., $10K; 12' alum. boat, V-hull, w/oars, anchor, swivel seats, $210; car top boat carrier, $25. VanDenAvyle, 898-6474.

MOTORCYCLE sidecar, Calif. Friendship model, less than 300 miles, midnight blue w/optional tonneau cover & entry step, $1300, mounts for Goldwing. Barnard, 831-4114.

'77 VW van, new tires, new paint, new upholstery, $3000 OBO. Armstrong, 298-4526.

'79 EL CAMINO, Royal Knight, loaded, $4300. Freshour, 265-0617.

SAILBOAT, '77 South Coast 22, sleeps 5, 7HP outboard, swing keel, pop top, $5800. Bouton, 898-3562.

10-SPD. bike, womens, 19", Mizutani, Dia-compe center pull brakes, Suntour derailleur, blue, ridden twice, $100. Kaiser, 296-5215.

'84 BRONCO II XLS, V6, AC, PS, tilt wheel, auto. lock, 5-spd., O/D, CC, extras, $12,300 OBO. Pyo, 822-9056.

'77 YAMAHA 650, 9K miles, 6" extension, custom paint, chrome, $1300 or deal for small truck. Rembold, 822-9173.

TRADE diesel 5-spd. '80 Rabbit, 4-dr., AM-FM, 47 mpg, 63K+ miles, for comparable Rabbit, gasoline model. O'Bryant, 268-9049.

'80 TOYOTA Corolla wgn., 40K miles, 5-spd., AM/FM, roof rack, $3750. Barnard, 256-7772.

'67 COUGAR (refurbished) 302 ZV, headers, AC, AT, PS, console, vinyl top, orig. interior, mag wheels, $3000. Phipps, 299-8490.

'79 CHEVY Caprice SW, all power, low miles, $2475 (NADA loan value). Moore, 345-4030.

'66 MUSTANG coupe, 289 V8, AT, PS, AC, orig. owner. Sundberg, 299-4764.

'79 HONDA CM-400T, 7K miles, kept in garage, windshield, crash bars, pegs & cruise control, $875. Perryman, 281-3020.

'78 TOYOTA Corolla 4-dr. auto., AC, below book, $2100. Baczek, 884-3668 after 4.

'69 DART G/T 273 V8, PS, AT, AC, new engine, new upholstery, new paint, rallye wheels, $2250. Anderson, 292-5676.

'79 TOYOTA Corolla 4-dr., AT, 55K miles, $2800. Gunter, 345-3022.

'83 MERCURY Capri, 6600 miles, 5.0 litres, 5-spd., AC, PS, PB, T-top, AM/FM cass., F/R spoilers, $9K. Crane, 281-9292.

'64 JEEP, Tuxedo Park Mark IV (CJ-7), low miles engine, 231-V6, 4x4, 3-spd. trans. Trompak, 293-2080.

⅓ OWNERSHIP in '76 Cessna Cardinal II, must hold at least a private ticket. Paul, 296-6500 after 5.

REAL ESTATE

SUPPER ROCK area, custom home, energy efficient, 3-bdr., 2 bath, formal DR, vaulted beam ceilings, views, below appraisal. Smith, 299-8469.

SIX-PLEX apartments, townhouse style, two 2-bdr., & four 1-bdr. units, approx. 6 yrs. old. Harrison, 883-5411.

MOUNTAIN land, 2½ acres just off N. 14 near Skytop Acres. Shipley, 298-2433.

1280 SQ. FT., 2-bdr., den, 1½ bath, on fenced ½ acre in SW valley, underground irrigation, fruit trees, $55K. White, 873-2137.

'81 14x75 WINDSOR, 3-bdr., 2 bath, fully furnished, $1500 down, take over payments. Farwell, 865-7494.

CARNUEL: 1.67 acres, Tijeras creek frontage, paved access, elec. & nat. gas to prop. line, never used well, 12 mins. to Base, $32K firm. Ortiz, 294-3907.

RIO GRANDE house, 3-bdr., sunroom, 2 baths, 2-story, 3 lots, beach, 2 miles Elephant Butte, $82K. Carson, 281-5115.

NEAR Candelaria & Tramway, 3-bdr., 1¾ bath, 6 yrs. old, lg. rooms, many extras, $96,500. Stein, 296-4255.

TOWN HOUSE, 2-bdr., 1330 sq. ft., 1¾ bath, 2-car garage, fp, NE heights, $81K, assumable CTL at 12¾%. Clement, 299-1501, 299-1542.

7.5 ACRES, irrigated & bordered by river, located at Ojo Caliente NM. Conklin, 821-6181.

WANTED

LIVING quarters for visiting faculty member, single male, May only. Easterling, 298-7083.

WHEELS for small truck, 6x14, 6-hole, qty. 2 or 3. Hueter, 299-7263.

BRIGGS & STRATTON 5 HP motor w/horizontal shaft, complete. Zender, 294-4145.

VERY reasonable shell for '81 Datsun king-cab. Caton, 294-4490.

ANYONE who taped last episode of "Jewel in the Crown" & is willing to share tape; playpen & infant toys for use in Neighborhood Center program. Shepherd, 296-1238 after 6.

HOUSING, summer faculty needs furnished 1-bdr. or larger apt. or house, May 20-Aug. 16. Blackwell, 292-5362.

CAMPER, pop-up style designed to fit International Scout II. Grigsby, 296-7131.

CAMPER JACKS. Ortiz, 294-3907.

WEED EATER, in good condition. Mitchell, 865-7941 after 5:30, Skinner, 865-9305, 9-4.

ROOMMATE desired to share house in Four Hills, $230/mo. plus util. Hsing, 293-5670.

CHAIN SAW, prefer 16" Homelite or McCulloch. Mooney, Sat. call 281-2612.

WIRE cage for Guinea pig, approx. 18x36". Armijo, 345-7385.

WORK WANTED

LAWN MOWING & power raking, estimates, references. Greg Cook, 296-3064.

Big Band Tonight; SERP Tomorrow

TONIGHT, Don Lesmen's big 11-piece band returns to the Club to play an evening of big band sounds for Friday night celebrating. Lesmen's group is gaining popularity these days by playing the arrangements of Glen Miller, Harry James, and Tommy Dorsey from the swinging big band era of the 1940s. The dining room offers another two-for-one special — either prime rib or scallops for $12.95. In the main lounge, Jean Hays plays an entertaining piano starting at 6. For reservations, call the Club office, 265-6791, *right now* to find out if there's a table left.

TOMORROW IS SERP Participants' Appreciation Night honoring all those Sandians who participate in Sandia recreation programs — from the Corporate Cup to arts and crafts classes. Recreation manager Stan Ford says this will be a great evening of dining and dancing at reduced prices. Topping the buffet spread (tab: $4.50) will be grilled-to-order steak, Talisman (a variety group) will play for dancing, and reduced bar prices will be in effect. Open to SERP participants and their guests, reservations are a good idea. Call 265-6791 *right now* to guarantee your table.

THE SINGLES EVENT last month pulled a reasonable crowd, both reasonable and enthusiastic. Another get-together is scheduled for Thursday, April 18. All singles on Base are invited to stop by after work, enjoy some free munchies, listen to Dunn's Dancing Machine, and move around some in the ballroom.

A LADIES NIGHT OUT is also scheduled on Thursday, April 18, in the dining room area. A Chippendale Jazzercise cassette will be playing on the big TV, free munchies will be spread, and very special bar prices will be in effect.

CASINO NIGHT is scheduled Saturday, April 20. For this popular event, the Club is converted to Las Vegas on the Rio Grande with casino action centered in the ballroom. There'll be crap tables, blackjack, poker, and chuckaluck. The only difference is that play money is used. The excitement is the same. Even music. Half & Half, country and western show band, will play from 8:30 to 12:30. Food service, available from 6:30 to 9, includes a selection of sandwiches and a green chile stew special for $1.35. Admission is $1 (guests $2).

Entertainment chairman Pat Conlon (7473) urges you to check the big display case in the Club lobby and eyeball the prizes to be given away by drawings every half hour during Casino Night. The loot includes a jogger's stereo radio, an AT&T "Speakerphone," a digital clock radio, an emergency CB radio, Chanel No. 5 perfume, a black and white television, and a portable stereo cassette recorder. The biggie, biggie grand prize (courtesy of Bolack International Travel) is five nights, six days in Honolulu for two — airfare, lodging, and transfers. Tickets for the drawings are part of the admission package, Pat says, but additional chances will be available for a minimal fee. "Increase the odds of taking home a prize," he says, "or use a prize to leave home."

Volunteers are needed to help man the blackjack and poker tables. Dealers will share a table, working half-hour shifts. If you'd like to deal poker, call Keith Mote (7482), 4-7523; blackjack, Ernie Montoya (7475), 4-7504. Your admission packet is free and so are dinner and refreshments.

THE THUNDERBIRDS, Coronado Club retiree group, plan a Spring Dinner Dance starting at 6 p.m. on Saturday, April 27. The event costs $7 (guests $8) and includes a roast beef and chicken buffet. Bob Weiler's Big Band Sounds will play for dancing. Make reservations early.

A director's meeting of The Thunderbirds is set for April 15 at 2 p.m. at the Club.

The Thunderbirds' card players meet at the Club on the first and third Mondays of each month at 10:30 a.m.

A TRAVEL PROGRAM on Hawaii by Thunderbird Travel is set for Monday, April 22, at 7:30 p.m. in the ballroom. Following the film and discussion, Marv Plugge (5171) will outline a Club-sponsored tour to Hawaii possibly this summer.

A Club-sponsored charter bus trip to Las Vegas May 26-29 still has seats available. Cost is $110 and includes three nights lodging in Las Vegas, a tour of Hoover Dam, a breakfast, lunch, and drinks and snacks on the bus. Sign up at the Club office.

Marv announced three new Club sponsored-trips this week — Disneyland June 23-25, Colorado ski country in summer June 29-July 6, and Canyon de Chelly Oct. 20-21.

The Disneyland trip includes airfare and transfers, two nights lodging at the Travelodge, two days admission to Disneyland, and transportation from the hotel to the park each day. The $202 package price is based on adult double occupancy. For children from age 3 to 12 add $28 for the room and $98 airfare.

The Colorado in summer tour is a charter bus excursion through spectacular Rocky Mountain scenery to the Aztec ruins, Telluride, Crested Butte, Leadville, and Vail with time out for hiking, horseback riding, museum visits, golfing, tennis, swimming, or whatever. Cost is $229 per person, double occupancy, and includes busfare, lodging, refreshments, and some meals.

Canyon de Chelly is another charter bus trip to Anazazi and ancient Navajo ruins in a magnificent canyon. The package includes busfare, lodging, a Jeep tour of ruins on the canyon floor, breakfast, lunch, and refreshments. Cost is $112 single, $90 double, $85 triple, and $82 quad (four in a family).

Detailed information is available at the Club office where you can also sign up for the trip.

SWIM SEASON is approaching, which means thinking about swim lessons for kids and a pool and patio season ticket for the family. Tickets go on sale in the Club office on April 15 — $35 for a family of three or more, $25 double, and $12.50 single. Registration for swim lessons is scheduled May 4 from 9 to 12. Details at the Club office.

THE GRIEGO BROTHERS band featuring Sam Griego (7481), right, on guitar and vocals, plays a variety of danceable tunes at the Club on Friday, April 19. With brother Gerald, left, on bass and drummer Oscar Lozoya, Sam sings popular Spanish, country, and rock songs.

Retiree Deaths

Jan.-March

L.T. McKenzie (65)	Jan. 3
William Barlow (88)	Jan. 5
Lyle Dillingham (64)	Jan. 7
Mary Brunacini (75)	Jan. 13
Edward Hutson (77)	Jan. 22
John Harper (74)	Jan. 26
Eugenio Roybal (90)	Jan. 30
Patricio Garcia (69)	Feb. 2
Rafael Garcia (72)	Feb. 5
Max Lopez (66)	Feb. 10
Santiago Villareal (92)	Feb. 14
Max Ludeke (78)	Feb. 15
Dan Fenstermacher (69)	March 9
Andres Jaramillo (95)	March 9
William Shoemaker (66)	March 15
Marie Bowers (81)	March 18
Raymond Faltings (69)	March 24
Henry Black (65)	March 26

Sympathy

To Jim Dawson (7842) on the death of his father-in-law in Marble Falls, Texas, March 26.

To Elwin Schaefer (7831) on the death of his mother in Albuquerque, March 29.

To Willie Romero (7482) on the death of his brother in Albuquerque, April 2.

The Mystery of "You"

The hearts of millions of French cinemagoers used to throb when, halfway through the third reel, Jean Gabin and Michele Morgan switched from *vous* to *tu*. The switch conveyed as much meaning as a sonnet, plus a strong hint that she was no longer merely darning his sock. Your correspondent cherishes a fond memory of the day when his favourite French girl first addressed him as *tu* — after an acquaintance of only two years.

British and American tourists who like to try out their French or Spanish have been rewarded recently with the discovery that things move faster nowadays. Linguistic and social etiquette has eased since their schoolmasters told them that the pronoun *tu* could only be addressed to children, relatins, or other animals.

There was a time when upper-class Frenchmen and Spaniards said *tu* to their maids and mistresses and *vous* (or *usted*) to their wives and everybody else ... In the past few years, however, and most noticeably since the election of Socialist governments in France and Spain, *tu* and first names have become more acceptable .... Spanish television and radio interviewers call almost everything that moves *tu*, especially writers, singers, and beauty queens .... Not everybody likes this *tu* usage. Some see a lack of respect in the trendy familiarity. Elderly Spaniards sometimes complain to the press that officials or dentists have called them *tu* .... A French girl is still more likely to dance with a stranger who asks "Aimeriez-vous danser?" than with one who says "Tu danses?"

Even so, foreign teachers of French or Spanish will have to revise their old tutorials.

—The Economist

History of ICF at Sandia

Where We Came From, How We Got Here, What's Ahead

With proof of the ability to scale-up the focusing of an ion beam, Sandia heads into its third decade of ICF (inertial confinement fusion) research. But it wasn't fusion back then.

It's true that the work that was going on did lead to Sandia's entry into the fusion field; that began well before 1965: Bill Snyder recalls that it was in 1959 or 60 that Sandia realized it needed a laboratory source to simulate the effects of gamma rays on weapon components. And people in Bill's division (Ken Haynes, Ray Clark, Paul Beeson, and Chuck Martin) developed some electrically driven gamma simulators for such studies. The first one was a modified Fexitron (sold by Field Emissions Corporation) that was housed in Bldg. 824 and enclosed in screen to filter out electrical noise.

Later the group moved to the basement of Bldg. 6580 in Area V. Bill recalls inviting George Dacey, then VP Research, out (in 1962) to observe a shot on a developmental model of a high-voltage generator for a simulator. As soon as the shot button was pushed, vast quantities of molten copper spewed out on the floor, and the observers, including George, had to skitter out of the way. "A most dramatic presentation of your new hardware," George commented.

The researchers soon realized that the machine wasn't going to produce adequate gamma ray intensities over sufficiently large areas, so the search began for better ways to produce high voltage generators. A new lab was set up in Area V.

But it was not until 1965 that Bill and Tom Cook formed a new division headed by Tom Martin to build a large gamma ray simulator to simulate radiation effects for electronics hardening experiments. The division relied heavily on Charlie Martin's 1963-65 discoveries about basic pulsed power principles, including the means to provide intense electron streams. Charlie, the "father of pulsed power," headed a group at the Atomic Weapons Research Establishment, Great Britain's counterpart to nuclear weapons side of the Atomic Energy Commission.

Glen Kuswa remembers attending a conference on fusion at Los Alamos in those early days. "It was more like astrophysics than earthbound science then," he remembers. "Some thought it would take only a few kilojoules of energy to ignite a fuel pellet, others were sure it would take several megajoules" (a kilojoule is 1000 watt-seconds, a megajoule is a factor of 1000 higher, a million watt-seconds).

Sandia's first accelerator, Spastic (so named because of its operational characteristics), was built with help from AWRE's Tommy Storrs and Ian Smith. It used the Blumlein method of stacking pulse-forming lines to provide high output voltages.

The next Sandia accelerator was called Hermes, after the Greek god of science and invention (also of cunning and trickery, and conductor of the dead to Hades). Actually,

(Continued Next Page)

Ion Beams: Origin & End

Pulsed Power Accelerators From the Inside

Every pulsed power machine starts with a massive charge of electrical energy, built up with a "trickle charge" lasting about a minute and stored in huge capacitor banks — the Marx generators found in almost every Sandia machine. The capacitors are charged in parallel at low voltage and low current; they are discharged in series at high voltage and high current.

As the charge is released from the Marx generators, it takes the form of a compressed pulse of energy. (The pulsed power machine gets its high power by shortening this pulse one or more times, until it is possibly only a few tens of nanoseconds [billionths of a second] long. Every time the pulse is shortened, the energy is concentrated and its power is thereby increased.)

At the beginning of its flight from the Marx generator, the energy follows metallic conductive paths, moving across switches between stages as sparks when the potential buildup becomes high enough.

The energy is switched into water-insulated transmission lines, then into the diode, where electrical energy is used to create an ion beam, and where the ion beam will strike a fusion fuel pellet, causing it to implode. In theory, the energy released is 100 times the energy it takes to fuse the fuel in the pellet.

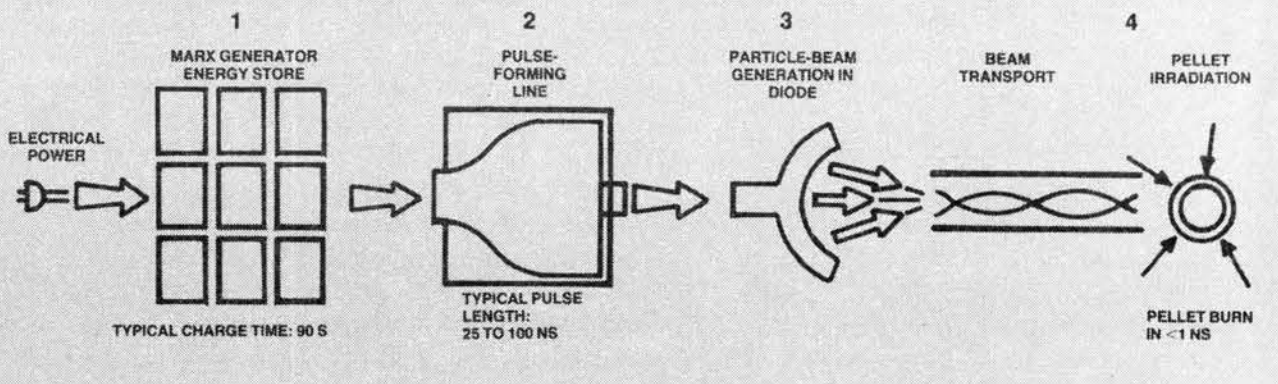
Basically, the diode consists of two roughly ring-shaped parts, the oppositely charged anode and cathode, surrounding a target chamber. At the innermost edge of the anode is an aluminum ring machined with fine grooves. This structure provides the ions — atoms from which an external electron has been stripped off, leaving the atoms with a predominantly positive charge. To provide carbon ions, for instance, the grooves are filled with carnuba wax; for protons, with plastic. When electrical energy reaches this location, it sparks across the grooves in a phenomenon called flashover, disrupting atomic and molecular structures and creating the all-important carbon ions.

The task at this point is to ensure that an efficient, stable beam of ions will leave the cathode and continue to the target location in the very center of the diode. This is done with a flashlamp and two parallel circular walls of plastic mesh. The flashlamp, operating in the extreme ultraviolet, partially pre-ionizes the area at the tip of the anode just before the electrical pulse arrives, conditioning it so that the main burst of ions is created promptly and efficiently.

The first mesh wall, a quarter inch from the anode, provides extra definition to a "virtual cathode" consisting of a magnetically confined wall of electrons. Because its charge is opposite to theirs, the cathode attracts and accelerates the positive ions toward and through it, inward toward the target.

Farther downstream, an inch or so away, the beam is neutralized as it takes on an extra surge of electrons that are produced as a second mesh is vaporized by the beam. This step allows the ions to continue on toward their target; otherwise, when there is too large an imbalance between positive and negative charges, there is a tendency for the ion beam to diverge radically (this is called space charge blowup), so that further focusing cannot be achieved.

Kinetic energy imparted to the ion beam in its first quarter inch of flight carries the sharp wave of ions and electrons to the target. In this last leg of the trajectory, they are impelleled wholly by ballistic forces. Additional focus — and thus more energy per square centimetre — can be achieved as in Proto I experiments, by giving the anode tip a lenticular (lens-like) profile.



BEGINNING WITH 'TRICKLE CHARGE,' intense target irradiation is achieved by compressing energy in time to get high power, and power in space to get high power density.

COUNTDOWN FOR THE FIRST SHOT on PBFA I (shown here during its dedication on Aug. 2, 1980) was an exciting time for Sandia's ICF community. Gerry Yonas, former director of Pulsed Power Fusion 1200, recalls that a fitting exploded at midnight on a Friday, "but at noon on Saturday the ground shook. The machine worked." PBFA I was the site of recent experiments proving that earlier achievements in focusing ion beams could be scaled up to large accelerators such as PBFA I and its successor, now under construction, PBFA II. (Rubber raft in photo is used for maintenance checks.)

there were two Hermes accelerators built — a prototype called Hermes I, which came on line in 1966, and the earlier conceptualized but later completed Hermes II. Both combined Blumlein transmission lines with Marx generators, Sandia's choice over Van de Graaff generators.

While Hermes I was being developed, President Hornbeck attended an open house in Area V. He noticed the switches Tom Martin was working on and remarked to Tom, "I tried to build one of these switches (at Bell Labs). It'll never work."

But it did. It was on Hermes I that Tom discovered the principle now known as magnetic insulation. Tom realized that the large cathode shanks Sandia was using didn't allow the electrons to be trapped by their own current as they would be in a smaller diameter shank. Once the cathode shank diameter was decreased, Hermes I produced its first beam — a week before being removed to make room for Hermes II.

When Hermes II was completed, Hermes I was converted from a gamma ray to an electron beam generator. The Marx generator from Hermes I was later used in REBA (Relativistic Electron Beam Accelerator). REBA went on line late in 1969 and was used to study radiation effects, materials properties, and (prophetically) electron beam propagation. It produced more than three megavolts and 50 kiloamps in a 70 nanosecond pulse. Its four-inch-diameter beam could be pinched down to allow somewhat tighter focusing.

Hermes II was considered a giant when it first came on line. Its 20-foot diameter gave it the potential to be the largest accelerator in the world at that time. The decision on size was hardly scientific — the Hermes II building had a door 20 feet high and the tank was simply rolled inside.

Nevertheless, Hermes II has proved to be a faithful workhorse in weapons effects and fusion research. With a design life of 1000 shots when it first went on line in 1968, it recently passed the 25,000-shot mark. And it was on Hermes that Tom's second major discovery took place — how to avoid the effects of "prepulse" voltages across the diodes, which altered the electron beam pattern from shot to shot dramatically and randomly.

The key was a new and simple cathode that's prepulse resistant. That is, its surfaces were rounded to prevent premature electron emission and to direct the electrons toward the target. (The cathode is still called the "Tom Martin cathode" by Sandia's collaborators at AWRE.)

About this time the question of whether electron beams could be made to propagate through a gas in anything but a random pattern became important. Such propagation, if achievable, would allow a "stand-off" distance between the end of the magnetically insulated transmission lines and the target to be zapped with the electron beams.

Research at the Naval Research Labs with an accelerator called Gamble (so-named because of the gamble that the beam could not propagate so the accelerator might not work at all) led to the discovery of a marvelous effect — self-pinching. It meant that, inside the diode, the beam was overcome by its own magnetic field and self-pinched in the anode-cathode gap, thus self-focusing the beam and giving it high intensities that allowed it to exit from the diode and propagate rather long distances.

This was physics no one had dreamed of. Later calculations and models showed that the beams ionized the background gas so that a return current is generated. If conditions are right, the return current can neutralize the incoming beam and allow it to propagate in almost a force-free region.

A new generation of accelerators was now possible, and Sandia's electron beam fusion program really evolved from the self-pinching phenomenon. The new accelerators were characterized by relatively low voltages (about 1 megavolt) but with currents that were about 10 times higher than earlier models — greater than 1 megaamp (million amperes). Such a configuration required an insulator with a large dielectric constant, and a simple one was available — water, rather than oil, became the prime dielectric.

While Hermes II was still under construction, Ken Prestwich built Sandia's first low impedance accelerator, a desk-sized device called Nereus. It was soon complemented by SLIM (see below) and by Hydra, a large, low impedance accelerator to provide hot X-rays for weapons effects studies. (Its name came from its water dielectric and from early plans to incorporate several modules and be "Hydra-headed.") Designed by Tom Martin and assembled by Ray Kline, Hydra came on line in 1972. It is probably the first accelerator that produced a beam on its first test firing.

Shortly thereafter, Steve Shope used Hydra in developing an improved cathode for ICF research. An extension of the self-pinch concept, it allowed extremely high current densities and the tightest focus ever produced to that time.

About this time, Sandia was trying to get

funding for a hot X-ray weapons effects device called Ripper (which would *rip* the leads from a microcircuit). But the attempt was unsuccessful.

In 1972, Gerry Yonas was hired to pursue other applications of the technologies Sandia had available — gamma ray work, Hermes, component development for Ripper, and more. Gerry remembers an interview with President Hornbeck at the Coronado Club in which Gerry sketched on a napkin a LIFE (lasers, ions, fusion, and electrons) program, "designed to breathe life into Sandia's pulsed power program," he recalls.

Sandia entered the fusion power field.

The first accelerator actually used in Sandia's inertial confinement fusion (ICF) program was called SLIM (Sandia Low Impedance Mylar-insulated accelerator). It was on SLIM that Ken and Gerry Yonas performed experiments that went beyond self-pinching, in which positively charged ions are added to the negatively charged electron beam. These ions neutralize the electrostatic charges and thus decrease the force of repulsion, allowing further pinching of the beam in the plasma regions beyond the diode.

Ken and Gerry's work showed that a pinched plasma could be introduced into the diode itself and provide a reproducible "super-pinch."

Working with John Freeman, Al Toepfer, Milt Clauser, and Jim Poukey, Gerry soon saw that directing this super-pinched beam onto a DT (deuterium-tritium) fuel pellet had possibilities in the area of ICF — and Proto I was conceived. (It was first called HARP — Have Another Ripper Prototype.)

Sandia was now competing with Lawrence Livermore and Los Alamos National Labs in the ICF area. Their programs were large and based on lasers; Sandia's program was small, some 10 percent of the overall program, and based on electron beams.

"Our approach was to pursue fusion ignition experiments," says Gerry. "Ignition would require a large energy source, and we felt that e-beams would have an advantage of high efficiency and low cost — lasers were very inefficient and quite small at the time, and very expensive.

"But we had many problems — focusing, coupling the energy into a target without destroying the diode." Proto I was a start toward some solutions.

Since ICF requires uniform radiation of the pellet, Tom suggested that Proto I incorporate a back-to-back design so that a pellet could be exposed to front and back beams simultaneously.

Another feature of Proto I was its short pulse. Fuel pellets are small and the implosion velocities are high, so the pulse time has to be short — 10 to 20 ns (billionths of a second), say. The voltage had to be less than 2 million volts or the X-rays produced would preheat the target. The low voltage and high current meant Proto I was low impedance. The combination of short pulse duration and low impedance made the accelerator design very challenging.

While Proto I was being developed, Tom Martin had Ripple constructed. At the time, no means of multichannel switching in water was known. But AWRE had a theory that, if the lines could be charged rapidly enough, several sites along a water-insulated line could be made to break simultaneously and produce short pulses. Sandia wanted to test this theory and at the same time learn whether the technology could be scaled up to larger accelerators. Ripple, with its high power but small size and with water as the dielectric, was designed to investigate the scheme. Ripple was then a proof-of-principle test bed for large water-insulated accelerators.

"It worked," recalls Tom. "If it hadn't, we wouldn't have the program we have today."

About this time (mid-74), Sandia hired Pace VanDevender, who had worked with AWRE's Charlie Martin while still in graduate school at the Imperial College of the University of London. Pace made Ripple a success — it proved that a machine using untriggered water switching could work.

That same year, Gerry was able to report some progress in overcoming the three primary barriers to inertial confinement fusion: 1) high-intensity beams had to be focused to the diameter needed to ignite a fuel pellet; 2) the cathodes that emit the stream of electrons had to be located far enough from the exploding pellet to escape damage; and 3) the electron pulse duration — 50 to 100 ns — had to be reduced to the 10 to 20 ns required for efficiently driving the pellet.

Proto II, its eight trillion watts power output making it the largest accelerator of its time, was built on the Ripple model and went on line in 1977. Principal designers were Tom, David L. Johnson, and Johann Seamen. Proto II's use of several smaller, highly synchronized accelerators connected in parallel demonstrated that very large accelerators could be built with this modular mode of construction.

Sandia next proposed EBFA I (electron beam fusion accelerator). Like Proto II, it would contain several channels; that is, it would be modular, thus permitting high power (30 TW, or trillion watts) with comparatively low voltages (about 2 MV, or million volts) and a pulse time in the 35 ns range.

EBFA I took advantage of years of experience in building accelerators. The Sandia team (Pace, Ken Bergeron, Jim Poukey, and Dillon McDaniel) plus Ian Smith, Phil Champney, and Mario DiCapua of Physics International had developed long transmission lines that were magnetically insulated to prevent an electrical potential of some two million volts from crossing a one centimetre gap. Each module of EBFA I provided 400 kiloamps in about 2 ns — the time it takes light to travel two feet — which is probably a world's record for rate of current change.

While the construction of EBFA was underway (thanks to Senator Joe Montoya), Sandia's fellow researchers at Cornell University discovered an efficient way to generate ion beams. Glenn Kuswa realized that, because of their shallower deposition — which means more energy delivered *into* the fuel pellet wall — ion beams were preferable to electron beams for ICF. Glenn became the Sandia zealot for using light ions. And after successful experiments showed light ion beams could be produced efficiently, EBFA became PBFA (particle beam fusion accelerator), "giving Sandia the freedom to accelerate anything," says Tom.

Once the decision was made to accelerate particles such as ions (which contain protons) rather than electrons, PBFA I needed considerably higher voltages — protons are some 2000 times heavier than electrons. And the polarity had to be reversed — the anode had to become the cathode and vice versa. Pace devised a "Chevy grille," a simple means to invert the polarity by cross-connecting the current-carrying input lines to the output lines.

"If that hadn't worked, we'd probably have given up the ICF effort," notes Tom. "It would have meant rewiring the generators, positive to negative, and that would have meant achieving only a quarter of the design power."

PBFA I's first shot was in 1980, two days ahead of schedule in a four-year development cycle. The countdown was "one of the most exciting things I've ever been involved in," says Gerry. "At midnight on Friday, a two-bit fitting exploded. We were almost out of money and time, the adrenalin and the excitement had been building for over 24 hours — but at noon on Saturday the ground shook. The machine worked."

Along with PBFA construction was a reemphasis on weapons effects work. At the same time, beam weapons work was heating up around the nation. So Sandia's effort grew now on three fronts — ICF, weapons effects, beam weapons.

PBFA II was already in the planning stage. Originally, it was planned to upgrade PBFA I from 36 generators and transmission lines to 72. But that would have meant shutting it down for the retrofit operation, and good research was coming off the accelerator.

But selling a new facility like PBFA II in Washington was not easy. It climaxed with Gerry, Al Narath, and Greg Canavan (then head of DOE's ICF program in Washington and now at Los Alamos) learning they had three days to get three signatures in Washington. The first two weren't easy, but the last one (by John Deutch) seemed impossible — until John asked, "This upgrade — is it going to be for electrons?"

"No, sir, I'm negative on electrons, I'm positive on ions," replied Gerry. "We're going for ions."

"I'll sign it," said John, and he did.

Planning for PBFA II began before PBFA I became operational. Sandia and DOE were committed to their construction years before the crucial question about beam focusing was resolved. That "fast-tracking" indicates the promise and excitement people found in the particle beam fusion program.

Challenge too — many physicists believ-

(Continued Next Page)

ed that light ion beams could never be focused: there were so many ions that they would be unstable, create defocusing electrical waves, and go in all directions. It took nine years of research by several dozen people using smaller (one trillion watt) accelerators to prove that light ions in intense beams are focusable.

David J. Johnson invented many of the concepts required to control the beam: flashover ion sources for more uniform ion emission, anode shaping for beam directing, and (with Phil Dreike, Steve Slutz, and Jeff Quintenz) gas-filled transport cells for force neutralization, for example.

Finally, in March 1983, with powerful new beam diagnostics from Ray Leeper and Bill Stygar, the last step was taken and an intense beam with the required beam divergence was achieved on Proto I. This proved the principle that light ions could be adequately focused — and under the worst conditions of high current density and low voltage.

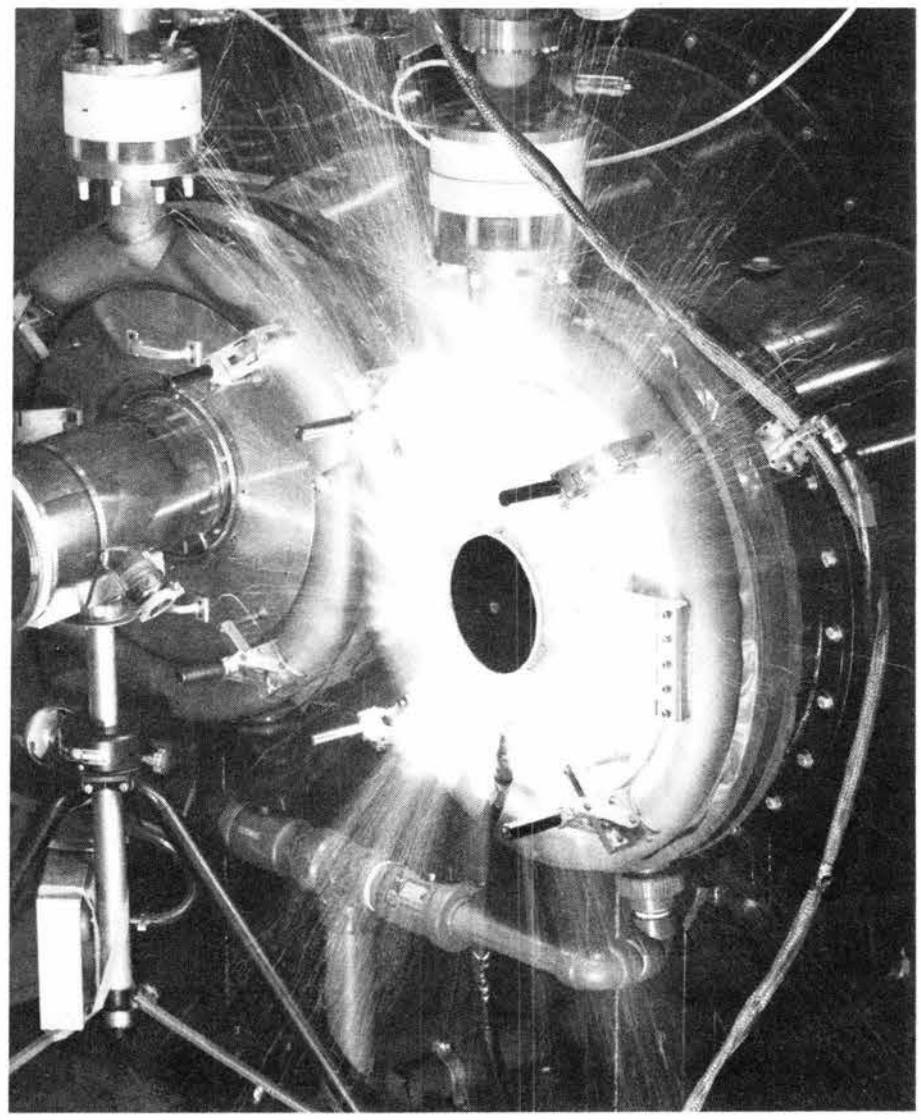
The next step was to scale this focusing to PBFA I and to do it at the current and diode size required for PBFA II. The PBFA I experiments had been progressing for three years. Slow but steady advances were made by chief experimenters Paul Miller, John Olsen, Phil Dreike, and Cliff Mendel and their many collaborators on each experiment.

"Learning to do science on huge accelerators like PBFA I was never easy," notes Pace VanDevender, now director of Pulsed Power Sciences, succeeding Gerry Yonas, who is now chief scientist in the Strategic Defense Initiative office in Washington. "In fact it was often painful. But each experiment — and each member of the scientific and operations teams — contributed to the advances. The major diode concepts — like the Pinch-Reflex, the Applied-B, and the Hybrid diodes — were rigorously tested against each other. And each test contributed to the understanding of the beam physics involved."

The most recent experimental team (see related story) has achieved adequate beam focusing on PBFA I at the total current required for PFBA II.

The next step in scaling — a factor of 20 in voltage — is expected to be easier. Both theory and the limited experiments performed thus far indicate everything gets better at higher voltage.

Focusing is not the only concern, of course. One series of experiments has been going on since the late 70s. It's an effort to replace water switches, which self destruct, with ones that are able to fire repetitively — the continual 10 shots per second it will take to create usable fusion power — and yet provide an output equal to water switches. By combining the World War II German concept of saturable inductors (magnetic switches) with the new amorphous metal technologies of the 1980s, Gene Neau (1252) and his fellow researchers have demonstrated magnetic switching at three trillion watts — more than 1000 times the power of any other magnetic switch. The tests will continue so the technology can be perfected for accelerators after PBFA II.



INTENSE ELECTRON BEAM creates a spray of molten metal as it strikes an aluminum target plate on Hydra (1974).

PBFA II is now believed to be the only fusion experiment in progress anywhere that has the possibility of igniting thermonuclear fuel in the laboratory. The ICF community is expectantly looking forward to the first shot in January 1986, to developing full power in a focused beam by October 1988, and to beginning implosion experiments soon thereafter.

PBFA II is expected to be a national ICF facility that will serve collaborators from Los Alamos and Lawrence Livermore National Laboratories, the Naval Research Laboratory, KMS Fusion, and the University of Rochester. However, producing the high voltage on PBFA II — a contribution of the Naval Research Laboratory and Sandia — is a major experiment after the accelerator reaches full power. "Scaling to the high voltage ion diode is not trivial," says Pace. "Conditions are favorable under the known physics, but there is still plenty of risk involved. The next few years will be very exciting."

The 100 trillion watt PBFA II is a unique facility that was uniquely built as well. The project team was led by Gerry Barr. He and PBFA II project coordinator Jim Furaus created a combination technical-administrative approach to project management that permitted PBFA II to proceed on schedule and within cost estimates while the criteria were still being defined by the research groups.

The result promises to deliver high performance with minimum time and cost. The quality engineering — under Tom Martin, Don Cook, and Ed Burgess — was recently praised during a review by the Davidson Committee as being excellent, unparalleled in the pulsed power field. "Such praise makes the difficulties of doing coordination and pulsed power engineering in the fast-track mode worthwhile," notes Pace.

Back in 1973, Gerry Yonas responded to a "What next?" question by saying "To predict exactly where we [fusion researchers] are going is like asking the Wright Brothers to design a 747 before Kitty Hawk."

Asked the same question recently, Pace VanDevender replied, "With PBFA II, we're launching *The Spirit of St. Louis.*"

CUTTING THE CAKE marking the success in focusing scale-up is Don Cook, manager of Fusion Research Department 1260.